Alberta Regeneration Survey Manual

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1.0 Introduction

1.1 General

In 1991, the legislative requirements for forest regeneration were amended to reflect an improved understanding and increased forest industry accountability for reforestation. At that time, a commitment was made to review the application and applicability of the new Alberta reforestation standard. A review of the standards by the Regeneration Survey Task Force, consisting of both industry and government, was concluded in March 2000 with the adoption of the "2000 Regeneration Standards".

A review of the Free-to-Grow (FTG) standards of the Performance Survey was completed in April of 2003. Several changes to the survey protocol and the FTG criteria were made to enable the retention of greater levels of vegetation adjacent to conifer crop trees that are growing well. These revised standards were adopted effective May 01, 2003.

In 2005, a review and edit was conducted to increase clarity of the manual; update the manual to reflect changes in natural subregion boundaries and references to associated documents; and to simplify the presentation of the manual. The revision was adopted effective May 01, 2006.

Changes to surveyor certification requirements and enhanced quality control and quality assessment requirements were included in 2007. These updates were adopted effective May 01, 2007.

The purpose of the Regeneration Standards is to ensure:

- Prompt reforestation following harvest
- Adequate stocking, survival and growth rates
- A level of performance that emulates natural yields found in Alberta's forests

Alberta's regeneration standards are expressed as measurable criteria that assess if forest establishment and performance objectives have been met. This manual provides the regeneration standards and survey procedures that are to be used to determine levels of re-growth and performance of desirable tree species on harvested forested lands.

1.2 Strata Standards

The 2000 Regeneration Standards continue to incorporate density, height and "Free-to Grow" status, as well as a minimum stocking standard. Under these updated standards, forest operators will be expected to reforest to one of four "strata standards". These strata standards are: Coniferous (C), Coniferous-Deciduous (CD), Deciduous-Coniferous (DC), and Deciduous (D).

1.3 Authority

Regeneration surveys are required to be conducted under the authority of the Timber Management Regulation, Part 6, Reforestation, Section 141.2. Timing and delivery of surveys is also specified in the Timber Management Regulation.

1.4 Organization of the Manual

A surveyor deals with one standard for an opening, depending on the years since harvest (Establishment or Performance) and the strata standard (C, CD, DC, or D). This manual is organized so that all information for a particular survey is located in a single section; Establishment in Section 2.0 and Performance in Section 3.0. The Wet, Low Density Standard is included separately in Section 4.0.

The field procedures and administrative requirements, which are common to all surveys, are detailed in Section 5.0 through 7.0. The Appendix includes a glossary, additional detail on procedures, as well as examples.

1.5 Types of Surveys

The 2000 Regeneration Standards utilize two surveys with timelines for delivery as follows:

1. An Establishment Survey must be completed no sooner than 4 years and no later than 8 years after the end of the year of cut in C, CD and DC openings; and no sooner than 3 years and no later than 5 years after the end of the year of cut in D openings.

2. A Performance Survey completed no sooner than 8 years and no later than 14 years after the end of the year of cut in C, CD, and DC openings; and no sooner than 8 years and no later than 14 years after the end of the year of cut in conditionally stocked D openings.

The regeneration start date is stated as after the end of the year of cut (the timber year) in which skid clearance was assigned. The timber year means the period from May 01st to April 30th.

The Establishment Survey will show stocking amount (percent), density (stems/hectare) and early growth of regenerated trees, as well as the approximate locations of satisfactorily restocked (SR) and/or not satisfactorily restocked (NSR) areas larger than 4 hectares (ha).

The Performance Survey will measure the same variables as the Establishment Survey to different standards, with the addition of conifer crop tree root collar diameter and identify coniferous crop trees deemed Free-to-Grow.

1.6 Applicability

Regeneration surveys conducted on all public lands within the Province of Alberta for the purpose of fulfilling obligations under the Timber Management Regulation are to be carried out according to procedures provided in this manual unless otherwise specified by Alberta. Details on related policies and aspects of enforcement may be described in directives posted or otherwise distributed by Alberta.

1.6.1 Regeneration Stratum Declarations

In conjunction with the requirements of the Regeneration Standard as outlined in this manual, the timber operator that is responsible to meet the Reforestation Standard is also responsible to follow the procedures set out in Directive 2005-1, "Regeneration Stratum Declarations and Allowable Cut Adjustments". This directive can be found at:

http://www.srd.alberta.ca/forests/managing/directives.aspx#policy

1.6.2 Alternative Standards and Methods of Survey

Notwithstanding the standards presented in this manual, alternative regeneration standards may be used where approved by Alberta. The forest operator must receive approval before employing survey methods that are contrary to those described in this manual.

2.0 Establishment Survey Standards

2.1 Timing of Survey

The Establishment Survey must be completed no sooner than 4 years and no later than 8 years after the end of the year of cut in C, CD and DC opening; and no sooner than 3 years and no later than 5 years after the end of the year of cut in a D opening.

The regeneration start date is stated as after the end of the year of cut (the timber year) in which skid clearance was assigned. The timber year means the period from May 1st to April 30th.

2.2 Stocking

The basic sampling unit is a ten square meter, circular plot 1.78 meters in radius. This sample plot is considered stocked if it contains at least one **crop tree** that meets the species and height parameters in Tables 2.2 and 2.3.

An opening will be considered Satisfactorily Restocked (SR) when the opening's total stocking equals 80% or more of the sample plots. The stocked plots must be distributed evenly over the sample area and must meet the minimum proportion specified in Table 2.1.

For D openings, two additional requirements exist: (1) the average number of deciduous crop trees per plot on the opening must be equal to or greater than the average number of deciduous crop trees by subregion and drainage class (Table 2.4), and (2) the minimum average height of deciduous crop trees must be met (Table 2.4).

In order to meet the minimum proportions of coniferous and deciduous stocking in CD and DC openings, the use of *overlapping plots* is permitted. Overlapping plots contain both a coniferous and deciduous crop tree and the same plot may be used twice in the calculation required to meet the minimum species proportions shown in Table 2.1. An overlapping plot is considered SR but may only count once in the opening's total stocking calculation.

2.2.1 Conditionally restocked openings in the Deciduous Standard

An area that is to be reforested to the deciduous standard will be considered **conditionally restocked** (CSR) if the following are true:

- 80% or more of the sample plots are stocked with at least one acceptable crop tree, and;
- 60% or more of the sample plots are stocked with at least one acceptable deciduous crop tree, and;
- the average height of deciduous crop trees on the opening is greater than or equal to the required average height of deciduous crop trees by subregion, ecosite, and drainage class (Table 2.4), and;
- *the average number of deciduous crop trees per plot on the opening is less than* the required average number of deciduous crop trees by subregion, ecosite, and drainage class (Table 2.4).

Table 2.1 Minimum Stocking Requirements for the Establishment Survey

	Harvest Date	Minimum Conifer Stocking	Minimum Deciduous Stocking	Minimum Total Stocking
C Standard	Areas harvested March 1, 1991 to April 30, 2000	70%	0%	80%
	Areas harvested After May 1, 2000 in Subalpine, Montane, Upper Boreal Highlands, & Upper Foothills	80%	0%	80%
	Areas harvested After May 1, 2000 in Central Mixedwood, Dry Mixedwood, Northern Mixedwood, Lower Boreal Highlands & Lower Foothills	70%	0%	80%
CD Standard	Areas harvested March 1, 1991 to April 30, 2000	50%	10%	80%
	Areas harvested After May 1, 2000	50%	30%	80%
DC Standard	Areas harvested March 1, 1991 to April 30, 2000	30%	30%	80%
	Areas harvested After May 1, 2000 in	30%	50%	80%
D Standard	Areas harvested after March 1, 1991	0%	60%	80%

2.3 Crop Trees

2.3.1 Crop Tree General Characteristics

A **crop tree** is a specific seedling/tree that meets *all* of the following criteria:

1. is an acceptable species (see Table 2.2) and,
2. has achieved the minimum height requirement and,
3. is alive, shows good health and vigour, is undamaged and,
4. has grown onsite for a minimum of three *growing seasons* (see page 38) and,
5. has originated from seed, suckering or coppice but **not** from layering and,
6. has a well defined stem with not more than two stems originating at the base nor more than three multiple lateral shoots not originating at the base (this does not apply to those deciduous species that regenerate through coppice growth. Each healthy stem in coppice growth may be considered a separate crop tree).

Advance growth is a specific tree that meets *all* of the above criteria and, in addition, the following:

1. was established in advance of the harvest and will probably be alive when the rest of the crop trees are harvested and,
2. has a live crown that extends two thirds or more of the tree height. The crown cover requirement does not apply to deciduous trees.

2.3.2 Acceptable Crop Tree Species

Table 2.2 details the crop tree species that are acceptable, including advance growth, on areas being reforested. Species that do not occur naturally in a subregion will not be accepted unless approved by Alberta.

Table 2.2 Acceptable Crop Tree Species Including Advance Growth

Coniferous Species	Deciduous Species
White spruce	Trembling aspen
Englemann spruce	Balsam (Black) poplar
Black spruce	White (Paper) birch
Lodgepole pine	Hybrid poplar[1]
Jack pine	
Whitebark pine	
Limber pine	
Tamarack	
Western larch	
Alpine larch	
Siberian larch [1]	
Douglas-fir	
Balsam fir [2]	
Alpine fir [2]	

[1] Utilization of non-native species for reforestation is only acceptable where a comprehensive strategy exists in an approved Detailed Forest Management Plan

[2] Balsam fir and Alpine fir may be considered acceptable species for specific opening as per directive # 2001-01. A copy of this Directive can be found at: http://www.srd.alberta.ca/forests/managing/manuals.aspx

The acceptability of fir on an opening-by-opening basis is determined prior to survey.

2.3.3 Crop Tree Height Requirements - C, CD and DC Standards

Table 2.3 details the minimum conifer and deciduous height requirements, by natural subregion, for a crop tree on areas being reforested to a C, CD or DC standard.

Table 2.3 Establishment Survey Crop Tree Height Requirements for C, CD and DC Standards

	Natural Subregion	Minimum conifer crop tree height (cm)[1]	Minimum deciduous crop tree height (cm)
C, CD and DC Standards	Central Mixedwood, Dry Mixedwood, Northern Mixedwood, Lower Boreal Highlands, Lower Foothills	30	120
	Subalpine, Montane, Upper Boreal Highlands, Upper Foothills	30	80

[1]The minimum height for Douglas fir is 15cm.

2.3.4 Crop Tree Height and Density Requirements - D Standard

Table 2.4 provides the minimum heights and numbers of trees for various species groups and sites as required to meet deciduous establishment standards.

Table 2.4 Establishment Survey Crop Tree Height and Density Requirements for D Standard

Natural Subregion	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)	Minimum average height of acceptable deciduous trees [2]	Minimum average number of acceptable deciduous per plot [3]
Central Mixedwood, Dry Mixedwood, Northern Mixedwood	Sw, Sb, Fb, Fa	VR, R, W, MW, & I	A – E	30	n/a	n/a
		P & VP	F - H	30	n/a	n/a
	Pl, Pj, Lt	VR, R, W, MW & I	A – E	60	n/a	n/a
		P & VP	F - H	60	n/a	n/a
	Aw, Pb, Bw	VR, R, W, MW, & I	A – E	80	160	7.0
		P & VP	F - H	80	120	5.0
Montane	Sw, Se, Sb, Fa	All	A – G (A – G)	30	n/a	n/a
	Fd	All	A – G (A – G)	15	n/a	n/a
	Pf, Pl, La	All	A – G (A - G)	60	n/a	n/a
	Aw, Pb, Bw	VR, R, W, MW, & I	A – E (A - F)	50	100	7.0
		P & VP	F – G (G)	50	75	5.0

Natural Subregion	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)	Minimum average height of acceptable deciduous trees [2]	Minimum average number of acceptable deciduous per plot [3]
Lower Foothills, Lower Boreal Highlands[4]	Sw, Sb, Fb, Fa	All	A – H	30	n/a	n/a
	Pl, Lt	All	A – H	60	n/a	n/a
	Aw, Pb, Bw	VR, R, W, MW, & I	A – E	80	140	7.0
		P & VP	F - H	80	100	5.0
Upper Foothills[5], Upper Boreal Highlands[4,5]	Sw, Se, Sb, Fa	All	A – J (A – H)	30	n/a	n/a
	Pl, Lt	All	A – J (A – H)	60	n/a	n/a
	Aw, Pb, Bw	VR, R, W, MW, & I	A – F (A – E)	50	100	7.0
		P & VP	G – J, (F – H)	50	75	5.0

[1]**Ecosites in brackets** are from the Field Guide to Ecosites of South Western Alberta, whereas the other ecosites are from the Field Guide to Ecosites of West Central Alberta and the Field Guide to Ecosites of Northern Alberta for the appropriate Natural Subregions. THESE ARE DETERMINED **BEFORE** HARVEST ONLY.

[2]**The average height of acceptable deciduous trees** is the arithmetic mean of the tallest deciduous tree from each **plot** in the opening stocked to deciduous species, excluding advance growth and those plots contributing to the declared conifer stocking percentage.

[3]**The average number of acceptable deciduous trees** is the arithmetic mean of the number of acceptable deciduous trees from all plots, excluding those plots that are stocked with coniferous trees. Plots that **contain** no trees must be included in this average. In each stocked plot, the maximum number of acceptable deciduous trees that may be used in the calculation is 10.

[4]For these subregions, ecosite types have not yet been defined. Drainage class shall be used for classifying an opening's condition for purposes of selecting minimum crop tree height and density.

[5]**In the Upper Foothills and Upper Boreal Highlands Subregions, the deciduous strata standard will only be allowed where the previous stand type was DC or D.**

3.0 Performance Survey Standards

3.1. Timing of Survey

The Performance Survey must be completed no sooner than 8 years and no later than 14 years after the end of the year of cut in C, CD and DC opening and must not be completed within 2 *growing seasons* (see page 38) after a stand tending treatment.

A Performance Survey is not required in openings satisfactorily restocked to the D standard in the establishment survey. Openings found to be conditionally restocked to the D standard, however, are subject to a deciduous performance survey that must be carried out no sooner than 8 years and no later than 14 years after the end of the year cut.

The regeneration start date is stated as after the end of the year of cut (the timber year) in which skid clearance was assigned. The timber year means the period from May 01 to April 30th.

It is possible to use one survey visit to collect the data required for both the Establishment and Performance Surveys in C, CD and DC openings, providing the survey is done in year 8, so that the minimum and maximum timing parameters are met for both types of surveys. However, the two growing season treatment rule must still be observed.

Two separate survey submissions are required if one survey is used to satisfy both the Establishment and Performance Survey requirements.

3.2 Stocking

The basic sampling unit is a ten square metre, circular plot 1.78 metres in radius. This sample plot is considered stocked if it contains at least one **crop tree** that meets the species, height and other characteristics as listed below.

An opening will be considered satisfactorily restocked (SR) when total opening stocking equals 80% or more of the sample plots. The stocked plots must be distributed evenly over the sample area and must meet the minimum proportions specified in Table 3.1.

For D openings, 80 percent or more of the sample plots must be stocked with at least one performing crop tree and a minimum of 60 percent of plots must be stocked with deciduous crop trees. In addition, the average height of the deciduous crop tree for the area has to be greater than or equal to the average height by subregion and drainage class as listed in Table 3.7.

As with the Establishment Survey, the minimum proportions of coniferous and deciduous in CD and DC openings may be met with the use of overlapping plots.

Table 3.1 Minimum Stocking Requirements for the Performance Survey

	Harvest Date	Minimum Conifer Stocking	Minimum Deciduous Stocking	Minimum Total Opening Stocking
C Standard	Openings harvested March 01, 1991 to April 30, 2000	70%	0%	80%
	Openings harvested after May 1, 2000 in Subalpine, Montane, Upper Boreal Highlands, Upper Foothills	80%	0%	80%
	Openings harvested after May 1, 2000 in Central Mixedwood, Dry Mixedwood, Northern Mixedwood, Lower Boreal Highlands, Lower Foothills	70%	0%	80%
CD Standard	Openings harvested March 01, 1991 to April 30, 2000	50%	10%	80%
	Openings harvested after May 1, 2000	50%	30%	80%
DC Standard	Openings harvested March 01, 1991 to April 30, 2000	30%	30%	80%
	Openings harvested after May 1, 2000	30%	50%	80%

3.3 Crop Trees

3.3.1 Crop Tree General Characteristics

A **crop tree** is a specific seedling/tree that meets all of the following criteria:

1. is an acceptable species (Table 3.4) and,
2. has achieved the minimum height requirement and,
3. is alive, shows good health and vigour, is undamaged and,
4. has grown onsite for a minimum of three *growing seasons* (see page 38) and,
5. has originated from seed, suckering or coppice but **not** from layering and,
6. has a well defined stem with not more than two stems originating at the base nor more than three multiple lateral shoots not originating at the base (this does not apply to those deciduous species that regenerate through coppice growth. Each healthy stem in coppice growth may be considered a separate crop tree).

Advance growth is a specific tree that meets all of the above criteria and, in addition, the following:

1. was established in advance of the harvest and will probably be alive when the rest of the crop trees are harvested and,
2. has a live crown that extends two thirds or more of the tree height. The crown cover requirement does not apply to deciduous trees.

3.3.2 Free-To-Grow

Under the Performance Survey, and in addition to the above criteria, both coniferous seedlings and coniferous advance growth must meet the criteria of **Free-to-Grow (FTG)** in order to be considered as a crop tree. **There is no Free-to-Grow requirement for deciduous species.** Within the Free-to-Grow definition, any broadleaved vegetation is deemed to be a competitor tree/shrub (other than mature residual deciduous trees) based on the following rules:

For surveys conducted 8-11 years after the end of the year of cut:

1. Any woody broadleaved vegetation that is within 1.78m (inside stem to inside stem) of the conifer crop tree, and
2. That is equal to or greater than 2/3 the crop tree height.

For surveys conducted 12-14 years after the end of the year of cut;

1. Any woody broadleaved vegetation that is within 1.78m (inside stem to inside stem) of the conifer crop tree, and
2. That is equal to or greater than the crop tree height, and,
3. With a base diameter equal to or greater than 70% of the conifer crop tree root collar diameter.

Conifer crop trees with no competing vegetation within the 1.78 m cylinder are considered to have met the Free-to-Grow criteria.

Conifer crop trees with competitors within the cylinder but meet specified performance criteria are considered to be **Provisionally FTG** according to the details provided in Table 3.2:

Table 3.2 Provisionally Free-To-Grow Requirements for the Performance Survey

	Species	Performance Indicators	Allowable Quadrants with competitors
C Standard	Spruces, firs	Last 2 year leader increment (total) => 60 cm OR total height => 2.5m	1 or 2
	Pines, larches	Height: diameter ratio < 55 OR total height =>3.5m	1
CD and DC Standards	Spruces, firs	None[1]	1
	Spruces, firs	Last 2 year leader increment (total) => 60 cm OR total height => 2.5m	2
	Pines, larches	Height:diameter ratio < 55 OR total height =>3.5m	1

[1]These crop trees are considered FTG and not provisionally FTG. Performance indicators are not required for these crop trees to meet the FTG criteria.

Provisionally FTG plots may be used in the calculation of the required minimum stocking levels (Table 3.1) according to the following maximum countable proportions shown in Table 3.3.

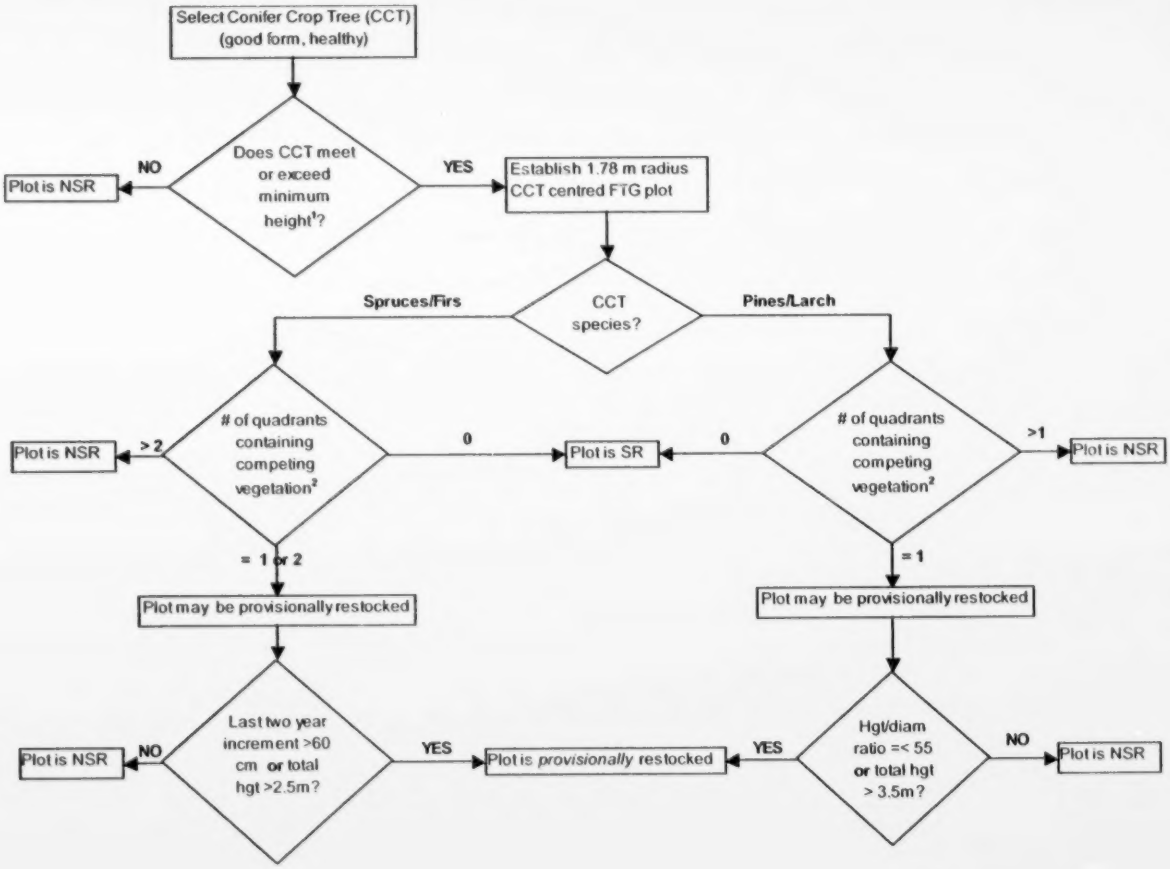
Provisionally FTG plots in excess of the allowable limits shown in Table 3.3 are considered to be Not Sufficiently Restocked (NSR).

Table 3.3 Allowable Percentages of Provisionally Free-To-Grow

Standard	Total Provisional	Provisional Spruces	Provisional Pines
C	30%	30%	10%
CD	25%	25%	10%
DC	15%	15%	10%

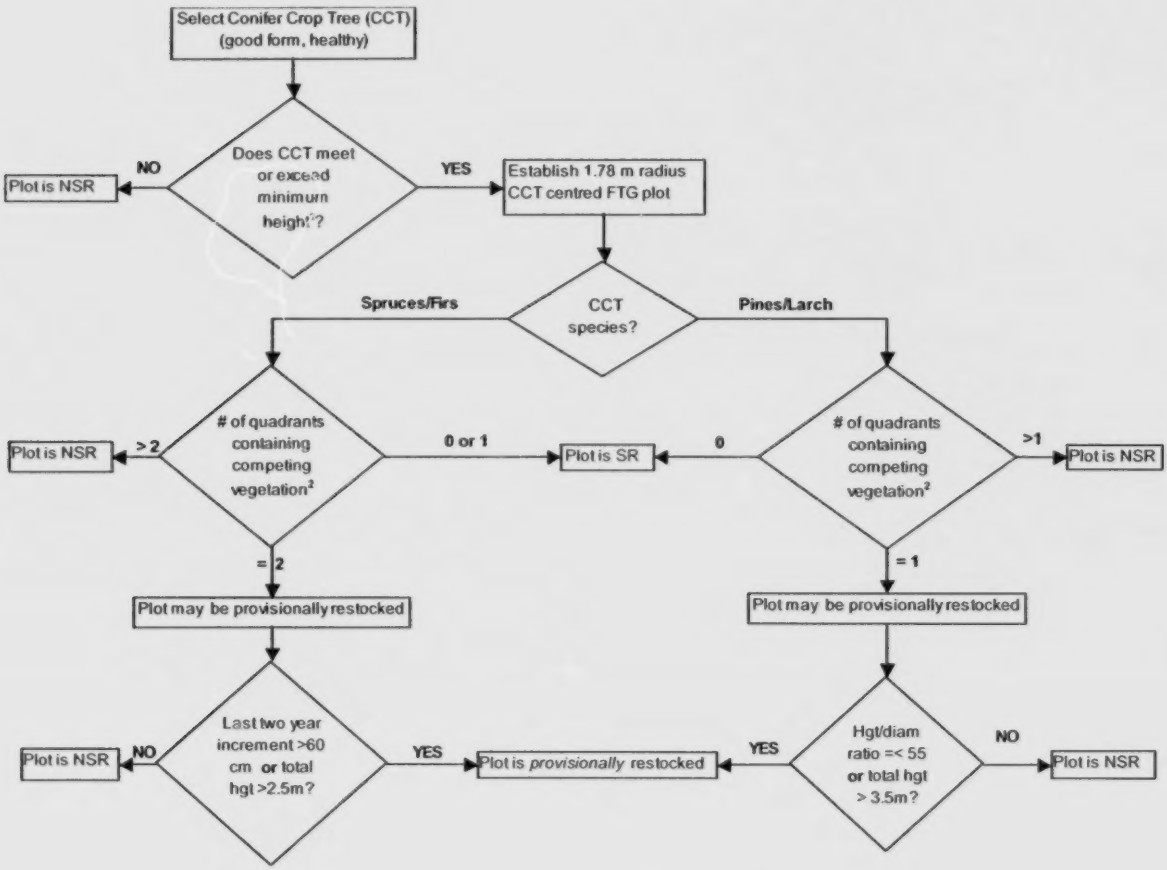
The following two flow diagrams may aid in the determination of provisionally restocked plots for the C standard (Figure 1) and the CD or DC standard (Figure 2).

Figure 1. Plot level decision tree for establishing plot stocking status of the Conifer standard



Notes:
[1] Minimum acceptable crop tree heights as listed in Tables 3.5.
[2] Competing vegetation either 2/3 height of conifer crop tree for surveys done between 8-11 years, or equal the height of the crop tree and has a base diameter greater than 70% that of the CCT base diameter for surveys done in years 12-14.

Figure 2. Plot level decision tree for establishing plot stocking status of the Mixedwood standards ("CD" and "DC").



Notes:

[1] Minimum acceptable crop tree heights as listed in Tables 3.5 and 3.6.

[2] Competing vegetation either 2/3 height of conifer crop tree for surveys done between 8-11 years, or equal the height of the crop tree and has a base diameter greater than 70% that of the CCT base diameter for surveys done in years 12-14.

3.3.3 Acceptable Crop Tree Species

Table 3.4 details the crop tree species that are acceptable, including advance growth, on areas being reforested. Species that do not occur naturally in a subregion will not be accepted unless approved by Alberta.

Table 3.4 Acceptable Crop Tree Species Including Advance Growth

Coniferous Species	Deciduous Species
White spruce	Trembling aspen
Englemann spruce	Balsam (Black) poplar
Black spruce	White (Paper) birch
Lodgepole pine	Hybrid Poplar[1]
Jack pine	
Whitebark pine	
Limber pine	
Tamarack	
Western larch	
Alpine larch	
Siberian larch[1]	
Douglas-fir	
Balsam fir[2]	
Alpine fir[2]	

[1] Utilization of non-native species for reforestation is only acceptable where a comprehensive strategy exists in an approved Detailed Forest Management Plan.

[2] Balsam fir and Alpine fir may be considered acceptable species for specific opening as per directive # 2001-01. A copy of this Directive can be found at:

Alberta SRD - Forests - Managing our Forests - Directives

The acceptability of fir on an opening-by-opening basis is determined prior to survey.

3.3.4 Coniferous Crop Tree Height Requirements - C, CD and DC Standards

Table 3.5a details the minimum coniferous performance height requirements for a FTG crop trees in C, CD and DC openings in the areas north of the North Saskatchewan River, whereas Table 3.5b details the same information for areas south of the North Saskatchewan River.

Table 3.5a Performance Survey Coniferous Crop Tree Height Requirements North of the North Saskatchewan River

Subregions - North of the North Saskatchewan River	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)
Central Mixedwood, Dry Mixedwood, Northern Mixedwood	Pl, Pj, Lt	VR, R, W, MW, &I	A – E	150
		P to VP	F – H	130
	Sb, Fa, Fb	VR, R, W, MW, &I	A – E	75
		P to VP	F – H	60
	Sw	VR, R, W, MW, &I	A – E	100
		P to VP	F – H	80
Lower Boreal Highlands[2], Lower Foothills	Pl, Pj, Lt	VR, R, W, MW, &I	A – F (A – E)	150
		P to VP	G – J (F – H)	130
	Sb, Fa, Fb	VR, R, W, MW, &I	A – F (A – E)	75
		P to VP	G – J (F – H)	60
	Sw	VR, R, W, MW, &I	A – F (A – E)	100
		P to VP	G – J (F – H)	80
Upper Boreal Highlands[2], Upper Foothills	Pl, Lt	VR, R, W, MW, &I	A – F (A – E)	125
		P to VP	G – J (F – H)	110
	Sb, Fa, Fb	VR, R, W, MW, &I	A – F (A – E)	65
		P to VP	G – J (F – H)	55
	Sw, Se	VR, R, W, MW, &I	A – F (A – E)	85
		P to VP	G – J (F – H)	70
Montane	Pl, Pf	VR, R, W, MW, &I	A – E (A – F)	105

Subregions - North of the North Saskatchewan River	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)
		P to VP	F – G (G)	95
	Sb, Fa	VR, R, W, MW, &I	A – E (A – F)	55
		P to VP	F – G (G)	45
	Fd	VR, R, W, MW, &I	A – E (A – F)	35
	Sw, Se	VR, R, W, MW, &I	A – E (A – F)	70
		P to VP	F – G (G)	60
Subalpine	Pl, Lt, La	VR, R, W, MW, &I	A – D (A – F)	105
		P to VP	E – I (G – H)	95
	Sb, Fa	VR, R, W, MW, &I	A – D (A – F)	55
		P to VP	E – I (G – H)	45
	Sw, Se	VR, R, W, MW, &I	A – D (A – F)	70
		P to VP	E – I (G – H)	60

[1]**Ecosites in brackets** are from the Field guide to Ecosites of South Western Alberta, whereas the other ecosites are from the Field Guide to Ecosites of West Central Alberta and the Field Guide to Ecosites of Northern Alberta for the appropriate Natural Subregions. THESE ARE DETERMINED BEFORE HARVEST ONLY.

[2]For these subregions ecosite types have not yet been defined. Drainage class shall be used for classifying an opening's condition for purposes of selecting minimum crop tree height and density.

Table 3.5b Performance Survey Coniferous Crop Tree Height Requirements

South of the North Saskatchewan River

Subregion South of the North Saskatchewan River	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)
Lower Foothills	Pl, Lt	VR, R, W, MW, &I	A – F (A – E)	100
		P to VP	G – J (F – H)	85
	Sb, Fa, Fb	VR, R, W, MW, &I	A – F (A – E)	55
		P to VP	G – J (F – H)	45
	Sw	VR, R, W, MW, &I	A – F (A – E)	75
		P to VP	G – J (F – H)	65
Upper Foothills	Pl, Lt	VR, R, W, MW, &I	A – F (A – E)	80
		P to VP	G – J (F – H)	70
	Sb, Fa	VR, R, W, MW, &I	A – F (A – E)	55
		P to VP	G – J (F – H)	40
	Sw	VR, R, W, MW, &I	A – F (A – E)	70
		P to VP	G – J (F – H)	60
Montane	Pl, Pf, Pw, Lw, Lt	VR, R, W, MW, &I	A – E (A – F)	60
		P to VP	F – G (G)	55
	Sb, Fa	VR, R, W, MW, &I	A – E (A – F)	45
		P to VP	F – G (G)	35
	Sw, Se	VR, R, W, MW, &I	A – E (A – F)	65
		P to VP	F – G (G)	55
	Fd	VR, R, W, MW, &I	A – E (A – F)	35

Subregion South of the North Saskatchewan River	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)
Subalpine	Pl, Pf, Pw, Lw, Lt	VR, R, W, MW, &I	A – D (A – F)	60
		P to VP	E – I (G – H)	55
	Sb, Fa	VR, R, W, MW, &I	A – D (A – F)	45
		P to VP	E – I (G – H)	35
	Sw, Se	VR, R, W, MW, &I	A – D (A – F)	65
		P to VP	E – I (G – H)	55
	Fd	VR, R, W, MW, &I	A – E (A – F)	35

[1]**Ecosites in brackets** are from the Field guide to Ecosites of South Western Alberta, whereas the other ecosites are from the Field Guide to Ecosites of West Central Alberta and the Field Guide to Ecosites of Northern Alberta for the appropriate Natural Subregions. THESE ARE DETERMINED BEFORE HARVEST ONLY.

3.3.5 Deciduous Crop Tree Height Requirements - C, CD, and DC Standards

Table 3.6 details the minimum deciduous performance height requirements, by subregion and site type, for a deciduous crop tree in C, CD and DC openings.

Table 3.6 Performance Survey Deciduous Crop Tree Height Requirements for C, CD and DC Openings

Natural Subregion	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)
Central Mixedwood Dry Mixedwood, Northern Mixedwood	Aw, Pb, Bw	VR, R, W, MW, & I	A – E	200
		P to VP	F - H	150
Lower Boreal Highlands[2], Lower Foothills	Aw, Pb, Bw	VR, R, W, MW, & I	A – F (A – E)	175
		P to VP	G – J (F – H)	125
Upper Boreal Highlands[2], Upper Foothills	Aw, Pb, Bw	VR, R, W, MW, & I	A – F (A – E)	150
		P to VP	G – J (F – H)	115
Montane	Aw, Pb, Bw	VR, R, W, MW, & I	A – E (A – F)	150
		P to VP	F – G (G)	115
Subalpine	Aw, Pb, Bw	VR, R, W, MW, & I	A – D (A – F)	150
		P to VP	E – I (G – H)	115

[1]**Ecosites in brackets** are from the Field guide to Ecosites of South Western Alberta, whereas the other ecosites are from the Field Guide to Ecosites of West Central Alberta and the Field Guide to Ecosites of Northern Alberta for the appropriate Natural Subregions. THESE ARE DETERMINED BEFORE HARVEST ONLY.

[2]For these subregions ecosite types have not yet been defined. Drainage class shall be used for classifying an opening's condition for purposes of selecting minimum crop tree height.

3.3.6 Crop Tree Height Requirements for the D Standard

Table 3.7 provides the minimum and average heights for various species groups and sites as required to meet the deciduous performance standard.

Table 3.7 Performance Survey Crop Tree Height and Average Height Requirements for D Openings

Natural Subregion	Species	Drainage Class	Ecosite[1]	Minimum crop tree height (cm)	Minimum average height of acceptable deciduous trees[2]
Central Mixedwood, Dry Mixedwood, Northern Mixedwood	Pl, Pj, Lt	All	A – H	160	n/a
	Sw, Sb, Fb, Fa	All	A – H	80	n/a
	Aw, Pb, Bw	VR, R, W, MW, &I	A – E	200	400
		P to VP	F – H	200	300
Lower Boreal Highlands, Lower Foothills	Pl, Lt	All	A – J (A – H)	160	n/a
	Sw, Sb, Fa, Fb	All	A – J (A – H)	80	n/a
	Aw, Pb, Bw	All	A – J (A – H)	150	250
Upper Boreal Highlands[3], Upper Foothills	Pl, Lt	All	A – J (A – H)	160	n/a
	Sw, Sb, Fa	All	A – J (A – H)	80	n/a
	Aw, Pb, Bw	VR, R, W, MW, &I	A – F (A – E)	150	250
		P to VP	G – J (F – H)	150	190
Montane	Pl, Pf, Lt	All	A – G (A – G)	160	n/a
	Sw, Sb, Fa, Fd	All	A – G (A – G)	80	n/a
	Aw, Pb, Bw	VR, R, W, MW, &I	A – E (A – F)	150	250
		P to VP	F – G (G)	150	190

[1]**Ecosites in brackets** are from the Field guide to Ecosites of South Western Alberta, whereas the other ecosites are from the Field Guide to Ecosites of West Central Alberta and the Field Guide to Ecosites of Northern Alberta for the appropriate Natural Subregions. THESE ARE DETERMINED BEFORE HARVEST ONLY.

[2]**The average height of acceptable deciduous trees** is the arithmetic mean of the tallest deciduous tree from each plot in the opening stocked to deciduous species, excluding advance growth and those plots contributing to the declared conifer stocking percentage.

[3]For this subregion, ecosite types have not yet been defined. Drainage class shall be used for classifying an opening's condition for purposes of selecti nimum crop tree height and density.

4.0 Wet, Low Density Standard

Sites with poor or very poor drainage combined with low original stand density may, if approved by Alberta prior to harvest, be reforested to a modified stocking standard (**Wet, Low density Standard**). Approved Wet, Low Density Standard openings will be considered satisfactorily restocked when 50% or more of the sample plots are stocked with at least one coniferous crop tree (crop tree as defined in previous sections of this manual). The stocked plots must be distributed evenly over the sample area.

An opening is a **candidate** for the Wet, Low Density Standard when:

(a) The original stand cover type indicated an A or B density or an ecosite assessment indicates poor drainage (P-VP) and poor nutrient level, or

(b) The original stand cover type indicated an A or B density or an ecosite assessment indicates very poor drainage (VP).

Height requirements are the same as those described for C, CD, and DC standards. There is no Wet, Low Density Standard for deciduous (D) strata openings.

5.0 Field Survey Procedures

In order to ensure that regeneration surveys are completed and reported consistently across Alberta, procedures and reporting forms are standardized. Regeneration survey information and data is to be recorded on the Regeneration Survey Information Sheet, Regeneration Tally Sheet, and the Regeneration Survey Field Map Sheet and Regeneration Survey Summary sheet. The templates for these forms are available from the Alberta Sustainable Resource Development website:

Alberta SRD - Forests - Managing our Forests - Manuals

This chapter describes the standardized methods for conducting surveys, completing the tally, information and summary sheets and drafting the field map. **All information contained on the tally sheets is mandatory to record, unless otherwise indicated.**

5.1 Opening Survey Information

The Regeneration Survey Information Sheet is the first page in the Regeneration Survey Tally Sheet package. The Regeneration Survey Information Sheet identifies the opening and provides data needed to determine the standards on a per-plot and opening basis. The following descriptions are provided to help explain what is required for each heading on the form:

5.1.1 Survey Details	
Survey Date:	Day, month, and year of survey completion
Surveyed by:	Name of qualified surveyor and other surveyors. Primary surveyor first, helpers second.
Certification Number:	Number assigned by Alberta to the primary surveyor who has met the qualifications for certification.
5.1.2 Opening Description and Survey Type	
Opening Number:	The official opening number used by Alberta for record keeping, tracking and future reference. This number is assigned to the opening according to the legal location of the centre of the opening. The assigning of this number legitimizes the opening in the Provincial records and is mandatory.
Disposition:	The FMA, license or permit number under which the opening was harvested.
Holder/ Operator:	The company responsible for reforestation.
Skid Clearance Date:	The year in which skid clearance was assigned to the opening. This date defines the "year of cut" to determine the reforestation clock start date.
Company Block Number:	A unique number used by the timber operator.
Field Number:	Opening identifier common to company or Forest Area assignment. Not as universal as the Opening Number.
Forest Area:	An Alberta administrative unit.

Subregion:	Alberta's forested areas are classified into geographical areas, which exhibit similar natural forest vegetation. Enter the short version of the Natural Subregion. DM Dry Mixedwood CM Central Mixedwood NM Northern Mixedwood UBH Upper Boreal Highlands LBH Lower Boreal Highlands LF Lower Foothills UF Upper Foothills SA Subalpine MO Montane
Ecosite:	Within each subregion, openings or portions of openings can be classified into plant community types. This ecosite categorization will have been determined in the pre-harvest survey. Enter the ecosite code as in "E1.1". Choosing to not fill in this data category may mean that a desired minimum standard may not be applied.
Drainage Class:	Drainage assessments provide a standard method for assessing soil moisture conditions. Enter the code of the drainage class for the opening or the portion of the opening. Choosing not to fill in this data category may mean that a desired minimum standard may not be applied. Drainage classes are provided in Section 5.3.9.
General Location:	Because Natural subregions may extend great distances north and south, the regeneration survey makes a separation using the North Saskatchewan River as the border. Circle either North or South in reference to the North Saskatchewan River.
Survey Type:	Check the appropriate box as to whether the survey is an Establishment or a Performance. Wet, Low Density Standard is also available to be selected and is to be determined in a pre-harvest period.
Fir Acceptable:	Check the box in this category if fir has been deemed an acceptable species by virtue of Policy Directive 2001-01. This must be determined prior to harvest.
Strata Standard:	This identifies the species mix which reforestation efforts are expected to produce, and hence the survey standard to be used. Circle the appropriate strata standard for the opening as it was originally classified. The codes used are defined as follows: **C** Coniferous **CD** Coniferous/Deciduous mixedwood **DC** Deciduous/Coniferous mixedwood **D** Deciduous

Survey Grid:	The survey grid is the selected line and plot spacing in Section 5.1.4. ▪ Line spacing is the distance between plots along the line measured in metres to the nearest 0.1 metres. ▪ Plot spacing in the distance between plots along the line measured in metres to the nearest 0.1 metres.
Opening Area:	Area in hectares, commonly determined after harvesting using aerial photos, GPS unit or traverse of the perimeter.

5.1.3 Determining the Number of Sample Plots Required

The number of plots required within the various sizes of openings is shown in Table 5.1.

Table 5.1 Sampling Requirements for Establishment and Performance Surveys

Opening Size (Ha)	Number of Sample Plots Required
0.1 – 1.9	Minimum of 12.4 plots/ha
2.0 – 4.0	Establish minimum of 41 plots/opening or as many as needed to cover opening. If stocking is in 73% - 79% range, intensify to 54 plots.
4.1 – 24.0	Establish minimum of 64 plots/opening or as many as needed to cover opening. If stocking is in 73% - 79% range, intensify to 84 plots.
> 24.0[1]	2.77 plots/ha

[1]To determine the number of sample plots needed for openings that are greater than 24 ha, multiply the gross opening area by 2.77 and round up to the nearest whole number.

5.1.4 Calculating the Survey Grid (line and plot spacing)

Square Spacing

The survey standard is a square grid pattern where the distance between lines equals the distance between plots. Once the total number of plots and the area of the opening are known, the survey grid (plot and line spacing) can be calculated.

$$\text{Plot spacing} = \sqrt{\frac{\text{Opening Area (ha)} \times 10{,}000\ (m^2/ha)}{\text{Required \# of plots}}}$$

Example:

For surveys on a 12.1 ha opening, calculate a square survey grid.

1. A 12.1 ha opening requires that 64 plots be established initially (Table 5.1)
2. Calculate the plot spacing:

$$\text{Plot Spacing} = \sqrt{\frac{\text{Opening Area (ha)} \times 10{,}000\ (m^2/ha)}{\text{Required \# of plots}}}$$

$$= \sqrt{\frac{12.1 \times 10{,}000}{64}}$$

$$= \sqrt{1890.625}$$

$$= 43.48$$

3. Round off to the nearest 0.1m:

line spacing = 43.5m plot spacing = 43.5m

NOTE: Appendix 4 contains calculated square spacing distances for various opening sizes.

Rectangular spacing

Line spacing may differ from plot spacing provided the line spacing does not exceed twice the plot spacing. For openings 24 ha and larger, a 60m by 60m square grid must be used.
In order to calculate rectangular spacing, one usually selects the desired line spacing, then calculates the plot spacing needed to achieve the correct number of plots.

Example:
For surveys on a 3.9 ha opening; calculate a rectangular survey grid, assuming a line spacing of 35m.

1. A 3.9 ha opening requires that 41 plots be established initially (Table 5.1)

2. Plot spacing x line spacing $= \frac{\text{Opening Area (ha) x 10,000 } (m^2/ha)}{\text{Required \# plots}}$

   Plot spacing x 35m $= \frac{3.9 \text{ ha x 10,000 } m^2/ha}{41 \text{ plots}}$

   Plot spacing $= \frac{951.22 m^2}{35m}$

   Plot spacing $= 27.17m$

3. Round off to the nearest 0.1m:
   line spacing = 35.0m plot spacing = 27.2m

5.2 Field Layout

5.2.1 Defining Ecosite and Site Drainage Classifications

All assessments of drainage class or ecosite classification will be conducted using site evaluation methods acceptable to Alberta. The classification will be conducted on a opening by opening basis by personnel suitably trained and experienced. If the forest operator wishes to indicate discrete and mappable areas of the opening where drainage class differences occur, the site evaluation information must be submitted along with the regeneration surveys.

Proper ecosite classification requires evaluation of the undisturbed plant community types and therefore must be conducted prior to harvest. In the case of ecosite classification where the equivalent to P-VP drainage class is expected, Alberta reserves the right to refuse the classification where a soil drainage assessment does not confirm the assumed moisture limitations for the ecosite.

5.2.2 Applicability

For D strata standard openings cut after May 1, 1998, and for C, CD, and DC openings cut after May 1, 2000, drainage and ecosite assessments conducted after harvest will not be accepted as just cause for modification to the classification (as defined by the VR to I drainage class by Natural Subregion).

For D openings with reforestation zero year commencing after March 1, 1991 but before May 1, 1998, and for C, CD, and DC openings with skid clearance after March 1, 1991 but before May 1, 2000, drainage class assessments contributing to the determination of opening status may be conducted up to the time of establishment survey.

5.2.3 Stratification by ecosite or drainage class

Where opening areas are to be separated into discrete areas of differing drainage classes or ecosite classes, it is expected that these areas will be delineated and treated as separate openings. For openings with areas of differing drainage classes, where it is not desirable to treat these as separate openings, the percentage of area for each drainage or ecosite class may be estimated.

For D openings containing small, scattered areas of differing drainage or ecosite, the new opening minimum average height and minimum trees/plot requirements are calculated based on the respective percentages for each ecosite or drainage class.

For the C, CD, and DC strata standards, ecosite and drainage stratification will not be allowed unless the areas are mappable and are greater than 0.04 ha in size. The status for plots within P-VP drainage areas of less than 0.04 ha is assessed according to the standards for VR-I drainage classes.

5.2.4 Control Lines and Survey Lines

For each area to be surveyed, control line(s) should be established for control of line plot and location as follows:

(a) Establish one control line that is parallel to the long axis of the opening. Additional parallel control lines are required every 400m where opening width exceeds 400m.

(b) The control line is usually placed in line with the grid so that points along the control line are used as plot centres. The control line(s) should be referenced to the opening boundary in order to be able to map the sample plot locations accurately. Starting from the opening edge, the first line is located at one-half the interline distance, and each additional survey line is marked at the exact distance line

(c) Survey line intervals on the control line are to be double flagged with two different colours and the line and plot number clearly written on the flagging.

(d) All survey and control lines are to be compassed and measured using a tape or string measuring device. All measured distances must be based on horizontal or surface projections.

5.2.5 Plot Layout

a. Beginning at the control line, the individual plots are located by compass and distance measurement.
b. The size of the sample plot shall be 1/1000 ha or $10m^2$.
c. The shape of the sample plot shall be circular and have a radius of 1.78m; the centre of the circle and the plot centre shall be a common point.
d. Every plot centre is to be clearly marked in the field. Mark plot centres with a stake firmly planted in the ground at the plot centre. Write the plot number and line number on a piece of flagging with a black, waterproof marker pen and then attach the flagging to the stick. Do not use grass herbs or shrubs to indicate plot centres.
e. Crop trees (both coniferous and deciduous) must be marked with flagging in every plot to facilitate field checking.

To determine if a stem is inside the plot, measure from the point where the plot stick enters the ground (plot centre) to the base of the stem. If ANY PART of the stem is within 1.78m of the plot centre, THE STEM IS IN THE PLOT.

5.2.6 Plots to Delete

In order for an area to be deleted from a regeneration survey, it must be under a disposition or classed as a "natural deletion". When it is known at the start of the survey that an area must be deleted from the opening due to an active disposition or natural deletion, the grid is to be calculated based on the reduced opening area. As the grid is being surveyed in, any plot landing on the deletion should be deleted. If the area of the deletion is correct, the proper number of plots to fill the opening should be obtained without moving any plots.

Examples of dispositions to delete from the opening area are:

- MLL - Miscellaneous lease (campsite, sand and gravel, etc.)
- PLA - Pipeline Agreement
- LOC - Licence of Occupation Road
- Well site
- Archaeological and historic sites
- Permanent sample plots or other research areas (in most cases)

Natural deletions to delete from the opening area are:

- Riparian areas and uncut buffers (no stumps encountered; 0.04 ha or larger)
- Uncut patches within the opening (no stumps encountered; 0.4 ha or larger)

Note that cutlines are not listed above as a disposition that is deleted from a opening area. Therefore, in openings harvested after May 1, 2000 and subsequently surveyed, plots falling on cutlines will not be deleted or moved but are to be tallied as they are encountered. In openings harvested before May 1, 2000, plots may be moved off of cutlines, as described in section 5.2.7. Cutlines were not usually planted in those openings harvested prior to May 1, 2000.

5.2.7 Plots to Move

While establishing plots, the surveyor may encounter a new disposition or natural deletion which will not be reforested and which had not been subtracted from the opening area at the time the grid was calculated. As a result, the grid may be set at a wider spacing than it should be in order to obtain the required number of plots. Therefore, when the disposition or unexpected deletion is encountered, the plot should be moved half the plot distance toward the next plot to help obtain the required number without adding plots later (see Section 5.2.8). If the plot still lands on the disposition, continue to move at one half the plot distance intervals until a plot can be established. The plot following a moved plot remains at its normal grid location.

5.2.8 Adding Plots

The minimum number of plots must be established (see Table 5.1). If additional plots are required to make up this minimum number, they should be spaced a follows:

a. Halfway between every third survey line (i.e., halfway between and parallel to the third and fourth survey lines, sixth and seventh lines, etc.)
b. Plot spacing should be the same on the additional lines as on the original lines to facilitate delineation of SR/NSR areas.
c. If use of every third line is not enough to add all the plots needed, proceed to add lines between other survey lines until the desired number of plots is reached. Lines must be marked on the control line and numbered with a sequential numeral (no letters).

5.3 Recording Plot Data on Tally Sheets

Regeneration survey data shall be recorded for each plot on the Regeneration Survey Tally Sheet. The following briefly describes the standards for plot measurements and completion of the appropriate blanks on the tally sheet. Use of tally sheets other than the standard forms must be approved by Alberta before surveying begins.

5.3.1 Line and Plot Numbers

Each plot is identified by a numerical plot and line number. For lines added after the initial grid is applied, the line must be given the next number in the sequence, not a letter.

5.3.2 Species

Enter the species code of those seedlings or trees chosen as suitable representatives of their species on that plot. A "suitable species representative" shares the same definition as that used for a "Crop Tree". The "Crop Tree" definition appears in Sections 2.3 and 3.3 of this manual.

Choose only one representative per species to record. Record a dominant tree greater than 30 cm for each species represented on a plot. You have the *option* of recording tree species that are under 30 cm. These seedlings would subsequently be labelled "undersized".

A situation that may occur is a species representative is over 30 cm and healthy but has not achieved the minimum height standard to pass the plot. This seedling is still required to be recorded but could not be used as a crop tree to pass the plot.

In this category, fir does not have to pass the criteria for an acceptable crop tree (for the purposes of passing the standard) in order to be considered a "species representative". If fir is present on the plot and is healthy and greater then 30 cm, it should be recorded as a species representative along with the rest.
Tree Species Codes are as follows:

White spruce **Sw**	Englemann spruce **Se**	Black spruce **Sb**
Lodgepole pine **Pl**	Jack pine **Pj**	Whitebark pine **Pw**
Limber pine **Pf**	Tamarack **Lt**	Alpine larch **La**
Western larch **Lw**	Siberian larch **Ls**	Balsam fir **Fb**
Douglas fir **Fd**	Alpine fir **Fa**	Trembling aspen **Aw**
Balsam poplar **Pb**	White birch **Bw**	Shrub competition **Sh**
Hybrid poplar **Ax**		

The above list can also be found on the Regeneration Survey Summary sheet for reference during the survey.

It is only a requirement to record the presence of shrubs on the plot if the shrub is clearly competition to a crop tree. No specific species need be recorded in this instance and the code given above is satisfactory.

The presence of a "Hybrid Poplar" or "Siberian Larch" code does not serve as approval of the use of this species in reforestation strategies. Approval for the use of these species in reforestation is still required from Alberta.

5.3.3 Type

Record the appropriate code for each species representative recorded in the "Species" column. The codes are defined below:

SDL – seedling (regenerated growth, planted or natural, not advance growth)
ADV – advance growth
SC – shrub competition. To be used as a code when doing Performance Surveys.
TC – tree competition. To be used as a code when doing Performance Surveys.

5.3.3.1 Competitor trees/shrubs (Performance Survey):

A competitor is a broadleaved tree or shrub that is taller than two-thirds the height of the crop tree (for surveys done between 8-11 years) or equal to the height of the crop tree and with a base diameter equal to or greater than 70% of the crop tree Root Collar Diameter (RCD) (for surveys completed between 12-14 years). The competitor may be located outside the plot area. If, on a CD or DC opening, a tree/shrub is found only in one quadrant of the crop tree cylinder (leaving 270 degrees surrounding the crop tree free of competitors) it is not considered as a competitor for spruce, larch, fir or Douglas fir trees, but is a competitor for pine trees. Mature residual deciduous and coniferous trees are not evaluated as competitor trees. Alder, willow, dogwood and other woody shrubs are considered competitor shrub species.

Record the competitor species as either TC (tree competition) or SC (shrub competition). Recording a tree as a competitor implies that the cylinder rule has **not** been met. The competitor tree (TC) may be one of the deciduous species representatives chosen for the plot.

The competitor tree (TC) must also be included as part of the density count if it is inside the plot.

5.3.4 Height

Measure and record the height of each species representatives in each plot to the nearest centimetre (cm). The height of the seedling/tree is measured from the base of the seedling/tree, at the average ground level, to the tallest reaching point of the live matter of the seedling/tree (see Figure 3). Seedlings are not to be stretched for this measurement.

In advanced growth trees, measure the height to the nearest centimetre for trees less than 100cm, to the nearest 10cm for trees greater than 100cm but less than 300cm, and if greater than 300cm, estimate to the nearest 100cm.

The height measurement assumes that the species representative is standing in a relatively vertical position. Seedlings or trees that lean greater than 30 degrees should not be chosen as species representatives or crop trees as the future form of a seedling or tree in this condition is suspect.

Height measurements on species representatives that are on a significant slope should be taken as described above but at the side of the tree, not on the uphill or downhill side (see Figure 4).

5.3.5 Age

Measure and record the age of each of the species representatives in each plot. Ages are a count of the number of branch whorls on coniferous trees and the number of bark scars on deciduous trees. Age estimates are to be made as accurately as possible. In advance growth, estimate as accurately as possible. To field-age a seedling, count the whorls, or breaks in the consistency of the bark, backwards from the present season's growth (terminal shoot), down to the root collar node. Add one year (season of germination to cotyledon) and record the age.

A *growing season* is considered to be June 20 through August 1 of any given calendar year.

Thus, in relation to the requirement that a crop tree or species representative tree must have grown on site for a minimum of three *growing seasons*, the seedling must have been planted prior to June 20 of the first calendar year and the survey completed after August 1 of the third calendar year. For example:

- A seedling planted prior to June 20, 2007 is considered eligible as a crop tree/species representative in a regeneration survey completed after August 1, 2009.
- A seedling planted in 2007, but on or after June 20, is considered eligible as a crop tree/species representative in a regeneration survey completed after August 1, 2010.

In relation to the requirement that a Performance Survey must not be completed within two *growing seasons* of a stand tending treatment, the stand tending treatment must have been completed prior to June 20 of the first calendar year and the survey completed after August 1 of the second calendar year. For example:

- An opening with a stand tending treatment completed prior to June 20, 2007 would be eligible for Performance Survey after August 1, 2008.
- An opening with a stand tending treatment completed in 2007, but on or after June 20, would be eligible for Performance Survey after August 1, 2009.

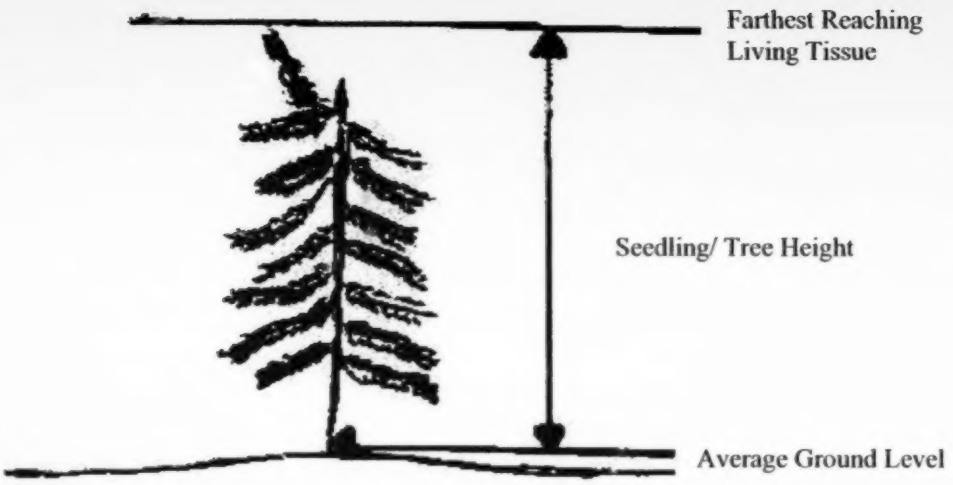


Figure 3: Measurement of Seedling / Tree Height on Flat Ground

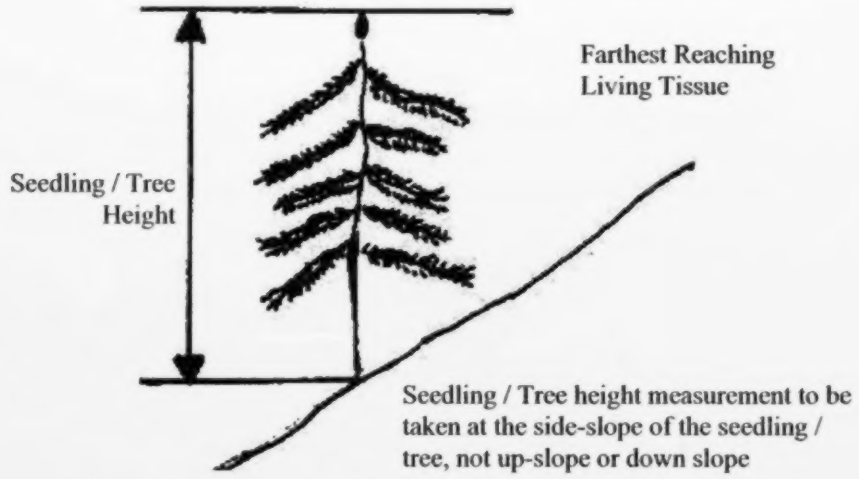

Farthest Reaching
Living Tissue
Seedling / Tree
Height
Seedling / Tree height measurement to be
taken at the side-slope of the seedling /
tree, not up-slope or down slope

Figure 4: Measurement of Seedling / Tree Height on Sloped Ground

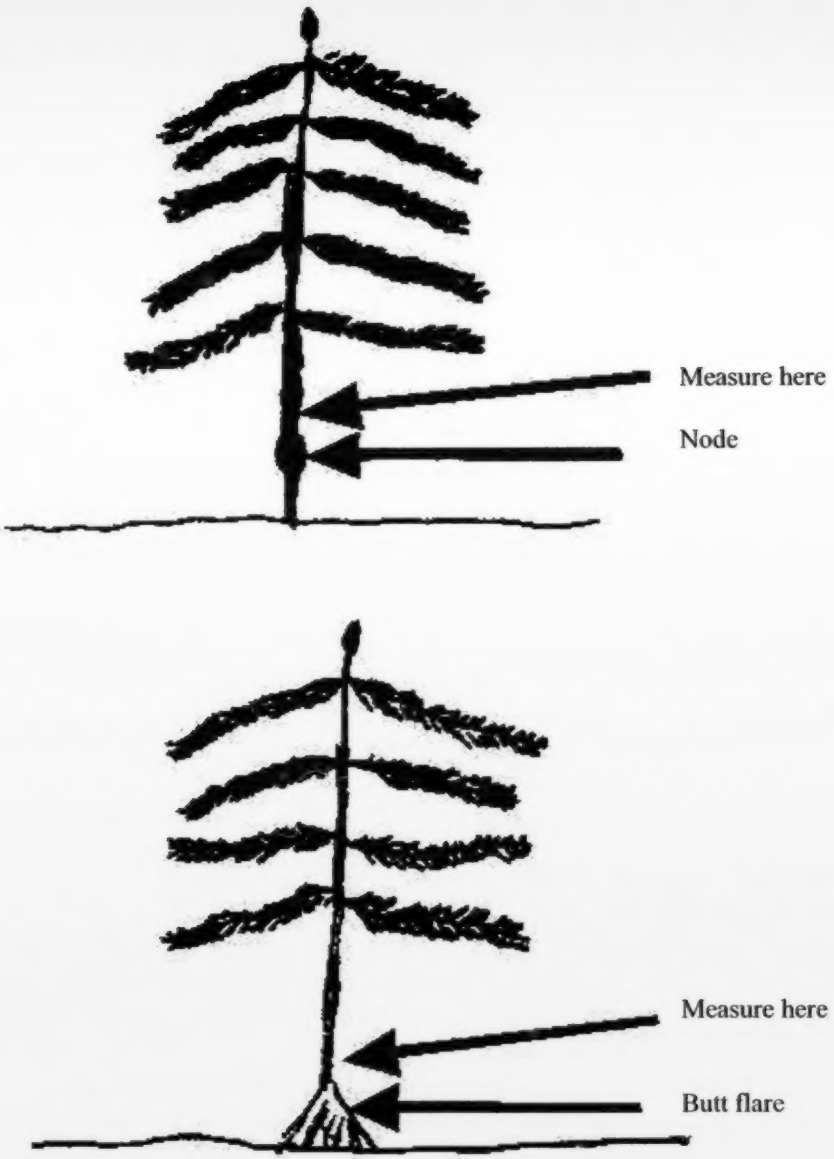


Figure 5: Measurement of Root Collar Diameter

Note: Butt flare should not be confused with an exposed root mass in a seedling. A partially exposed root mass may occur as the result of frost heave or poor planting. If this situation is encountered, the seedling should **not** be chosen as a crop tree as its future stability is suspect.

5.3.6 Root Collar Diameter

Root collar diameter (RCD) is a required measurement for a conifer crop tree, in the "Pines/Larches" category, in the Performance Survey only. If a Performance Survey is being performed 12-14 years after the end of the year of cut, an RCD measurement is required on the designated competition tree/shrub.

Measuring RCD involves using a calliper to record the diameter of the seedling to the nearest millimetre. Position the calliper at the base of the seedling, immediately above the root collar node and record the measurement. If the seedling or tree being measured for RCD exhibits significant butt swell at the base, move the measurement for RCD up to the point where the butt swell taper disappears and normal bole width is encountered (see Figure 5). For the purposes of checking, flag the seedling on which the RCD was measured.

If measuring RCD on tree or shrub competition with multiple stems from a single base, take the measurements on the stem that appears to be the largest in diameter.

5.3.7 Selected Crop Tree

In the case of the CD or DC standard, a surveyor may select as many as two crop trees for each plot, one coniferous and one deciduous. For the C or D standard, only one crop tree is chosen (a coniferous crop tree OR a deciduous crop tree) that would pass the plot to the specific standard.

The selected tree must meet the minimum height standard for the for the strata type. Surveyors are required to indicate the selected crop tree by recording an "S" in the "Selected Crop Tree" column, on the same line as the species chosen.

If re-designating the original survey to a different strata standard, ensure that all crop trees are properly labelled on the tally sheet. For the purposes of checking, surveyors are required to ribbon each species representative in each plot.

5.3.8 Free-to-Grow (FTG)

Record whether the selected coniferous crop tree is Free-to-Grow to the "allowable cylinder rule" using the designation "F" (Free growing) or record if it is a provisionally Free-to-Grow plot by using the designation "PF" (Provisionally Free growing) in the box on the same line as the selected crop tree.

To facilitate determination of the possibility of an opening meeting multiple strata standards (i.e. C, CD or DC) opening, one may wish to record whether the non-pine conifer is, in fact, FTG to the "Spruces/Firs" Performance Indicator. This choice is optional, but would serve to highlight the possibilities for the future in relation to other possible strata standards that could successfully be applied to the opening.

5.3.9 Drainage Class

Record the drainage class, as established in a pre-harvest assessment. The drainage class codes are as follows:

VR- very rapid **R**- rapid **W**- well **MW**-moderately well
I-imperfectly **P** – poor **VP**- very poor

If the drainage class for the whole opening remains as one class, this could be recorded once at the first plot and reiterated on the Regeneration Survey Information Sheet. If multiple drainage classes are to be applied to different plots in an opening, these multiple designations would be recorded in this column on the tally sheet.

5.3.10 Capped Acceptable Deciduous Density

This applies to the Deciduous Standard only and is the number of deciduous crop trees on the plot, to a "capped" total of ten, that would be recorded.

Enter a count of the number of deciduous crop trees that meet the minimum height requirements for the D stratum standard. Record "10" if there are ten or more deciduous crop trees on the plot.

5.3.11 Density

Collection of density by species data is not mandatory to meet a stratum standard. However, density data by species may be required as part of an operator's growth and yield plan. In such cases, for all strata standards in both the Establishment and Performance survey, record the density by species present on each plot. Data should be captured in both the category of "30+ cm" and, as needed, in the Lower Limit "L.L." category. Enter the count of all seedlings/trees within that species by category. Any crop tree or competition tree selected must also be included in the density count.

The category "L.L." is available as a means of capturing populations that are shorter than 30cm that could contribute to the stand yield later in the rotation.

5.3.12 Additional Columns on the Tally Sheet

The tally sheet contains four blank columns on the right hand side. These columns are available to the user to record other types of data that they feel relevant to collect while doing the survey. As well, certain companies or clients may choose to add specific data sets to a "tailored" version of the tally sheet. Any data recorded in these blank or added columns do not form any part of the requirements of the regeneration survey and are not considered mandatory by Alberta.

5.3.13 Survey Results

This is the last section that appears on the Regeneration Survey Information Sheet, which serves as the cover sheet to the regeneration survey data sheet package. The data recorded on the tally sheet is rolled-up into summary categories within this section. These categories are described as follows:

1. **Total Plots:** Record the total number of plots used to complete the survey, including those plots added to fill the opening and those plots added as the result of the stocking percentage falling within the 73-79 % range.

2. **Opening Stocking Percentage:**
   There are three sub categories here: Total, % Deciduous and % Coniferous. Transfer the data from the back of the map sheet into the appropriate category in this section.

3. **Average Deciduous Crop Tree Height:**
   Record this data if doing a deciduous survey. Take each of the deciduous crop tree heights per plot, add these up and divide by the number of crop trees used.

4. **Average Acceptable Deciduous Trees per Plot:**
   Record this data if doing a deciduous survey. Add the per-plot numbers of acceptable deciduous (capped at 10, record 10 if actual number is greater than 10) and divide by the total number of plots. Include those plots with **no** acceptable deciduous trees in them as a part of this calculation.

5. **Lower Limit Density (L.L.):**
   If requested to record density data on that population of a species on a plot below the 30cm height, record the density here.

6. **Opening Status:**
   Circle one of the categories below, based on what the opening was surveyed to and the final stocking percentages for the strata standard. The codes are explained as follows:
   CSR – conditional status applied to results of establishment survey in deciduous stratum standard.
   SR – satisfactorily restocked. Applies to those openings that pass their strata standard.
   NSR – not satisfactorily restocked. Applies to those openings that fail their strata standard, OR, contain a 4.0 ha contiguous patch of NSR area.

FTG – a subcategory of SR applied indicating a pass of the strata standard in the Performance Survey. Circle this category in addition to the application of the SR status.
NFTG – a subcategory of NSR indicating a failure to meet the strata standard in the Performance Survey. Circle this category in addition to the application of the NSR status.

7. **NSR Area (ha.):**

   The area of the opening that is NSR. This may be a contiguous area greater than 4.0 ha, or the entire area of the opening.

8. **Roads and Landings Area:**

   Record the cumulative area that was under roads and landings. Then, provide a percentage estimate of the amount of area under roads and landings compared to the total opening area.

9. **Survey Passes:**

   This is an optional recording mechanism that identifies which strata standards the opening could pass. One or more of these categories may be circled and used for future reference by both industry and government.

5.4 On-site Stocking Check

Before the regeneration surveyor leaves the opening, a check of the survey's statistical accuracy must be made. The details of the statistical accuracy standards are provided in Appendix 2. However the surveyor simply needs to confirm that a sufficient number of valid sample plots have been established, based on the calculated stocking percentage:

For openings 2.0 to 4.0 ha in size, where stocking is found to be between 73 – 79%, 54 plots are required rather than the 41 that would be initially established.

For openings 4.1 to 24.0 ha in size, where stocking is found to be between 73 – 79%, 84 plots are required rather than the 64 that would be initially established.

5.4.1 Recalculating the Regeneration Survey Area

The first step in ensuring there are enough plots is to confirm that the opening area is correct. The opening area may not always account for deletions of non-productive and non-forested areas within the perimeter. Use of a square survey grid with known distances between plots and lines permits an easy calculation of the opening area. The principle is that each plot location represents an area (in square metres) equal to the line spacing multiplied by the plot spacing. To

calculate the regeneration survey area multiply the area represented by one plot by the number of plots located in the grid. Divide by 10,000 to convert from square metres to hectares.

You may choose to record the calculated Regeneration Survey Area in the Survey Results box on the tally sheet. If not, the GPS area would be used.

$$\text{Regen survey area} = \frac{\text{line spacing x plot spacing x number of grid plots}}{10{,}000}$$

A **grid plot** is a non-deleted plot located on the predetermined plot and line spacing. Do not include plots that have been moved one half the plot distance, unless the reason for the move was a temporary deletion. Do not include plots, which have been deleted, or ones that have been added to lines not on the original line spacing (i.e. between lines).

5.4.2 Preliminary Stocking Percent

In order to determine if the stocking falls in the 73 – 79% range, a preliminary stocking percent is needed. Using the Stocking Summary table on the back of the Map Sheet, a preliminary stocking percent is calculated as follows:

Establishment survey stocking

1. For each species group, count the number of **satisfactorily restocked plots (SR)**; multiply by 100 and then divide by the total number of **valid** plots established so far to get a percent for each species group. All plots that have not been deleted are considered valid.
2. Add the percent for each of the species group to arrive at the preliminary stocking percent to the nearest 0.1%. Include the percent for plots stocked with both established conifer and established deciduous in the total opening stocking percent, but do not count any plot more than once.

Performance survey stocking

1. For each species group, count the number of **Free-to-Grow plots (FTG -** including all allowable provisionally FTG plots) and **deciduous (SR) plots**; multiply by 100 and then divide by the total number of **valid** plots established so far to get a percent for each species group. All plots that have not been deleted are considered valid.
2. Add the percent for each of the species group to arrive at the preliminary stocking percent to the nearest 0.10%. Include the percent of plots stocked with both FTG conifer and performing deciduous in the total opening stocking percent, but do not count any plot more than once.

5.4.3 Adding More Plots and Recalculating Stocking

Using the preliminary stocking percent and the recalculated area (Regen Survey Area), refer to the Table 5.1 to determine the number of plots required. If for any reason more plots are need to be established, follow the rules for adding plots as presented in Section 5.2.5.

5.4.4 Damage, Site Conditions, and Treatments Recommended

On the Regeneration Survey Summary sheet (the back of the map sheet) space is provided to record opening summary information specific to site conditions. Recording this data is optional, but may be very important for determining why a particular opening may have failed the survey. It will also help to determine what remedial action (further tending, cleaning, etc.) is needed to meet the management objectives. Keep track of any physical damage, insect or disease damage that you may observe on the crop trees or other trees in the plot and then report the extent of this damage on a opening basis using the table on the Regeneration Survey Summary sheet, (the back of the map sheet).

5.4.5 Field Map Completion

Field maps should be drawn on the standard Regeneration Survey Field Map Sheet as the surveyor progresses through the opening. This will help the surveyor map certain features of the opening and the status of the plots surveyed. Refer to Figure 6 for an example of a map.

All maps submitted are to show the following information for each opening surveyed:

a. Disposition and opening number.
b. Opening boundaries.
c. Total opening area. Use survey grid to check on opening area. Make corrections where necessary.
d. North arrow.
e. Location of control line(s) and tie point(s).
f. Location of survey lines and plots.
g. Plot numbers and line numbers.
h. The location and size of permanent deletions.
i. Symbols for stocking status and species grouping for each plot (see symbols below)
j. Scale of the map
k. Delineation of NSR areas (See Section 6.1.1 and example at end of this section)

All Surveys

- not cut or deleted plot

- undersized seedlings **(NSR)**

- non-stocked **(NSR)**

Establishment Survey

- stocked with coniferous crop tree **(SR)**

-stocked with deciduous crop tree **(SR)**

- stocked with **both** coniferous and deciduous crop trees **(SR)**

Performance Survey

- stocked with coniferous crop tree, **not** Free-to-Grow **(NSR)**

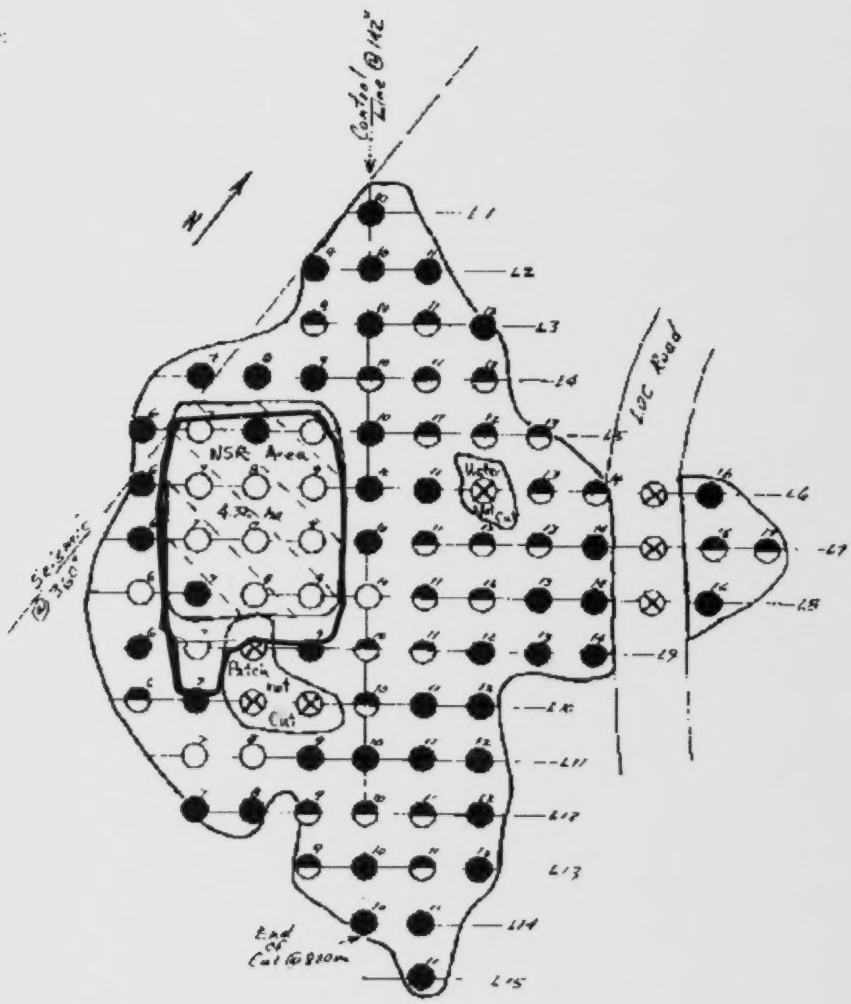
- stocked with Free-to-Grow **(FTG & SR)**

- stocked with performing deciduous crop tree **(SR)**

- stocked with **both** Free-to-Grow coniferous and performing deciduous crop trees **(FTG & SR)**

P - for checking purposes, mark "P" beside those plots on the map that are designated as provisionally FTG

Example:



Disposition : CTLS030002
Opening Number : 0761040012
Scale : 1:5000
Opening Area : 30.5 ha
Survey Date : May 1, 2000

Figure 6: Example of a Map

6.0 Survey Compilation

6.1 Preparing the final map

The final map to be submitted to Alberta must be either drawn on the Map Sheet or generated from a reliable computer program. If the field map and tally cards are neat and complete, they may be submitted; otherwise all information from field tally cards and field maps is to be transferred over to produce a neat, detailed drawing of the opening at a reasonable scale (preferably 1:5000). Ensure that all information required, as outlined in Section 5.4.5 of this manual, is on the map.

6.1.1 Identifying Poor Stocking Distribution

In addition to plot locations and symbols, the map is to show:

For an Establishment Survey:

1. The location and size of stocked areas larger than 2.0 ha within an otherwise NSR opening.

For a Performance Survey:

1. The location and size of Free-to-Grow areas larger than 2.0 ha within an otherwise not Free-to-Grow opening.

The process of delineation of 4 ha non-stocked patches (NSR holes) will be done using a moving average of plot status, checking in horizontal and vertical rows across the opening for areas which do not meet the required 80% stocking or Free-to-Grow requirement. The following procedure can be used for both Establishment and Performance Surveys for stocking and Free-to-Grow area delineation:

1. Identifying un-stocked areas within a generally stocked opening:
   a. Starting at one corner of the opening, proceed along the lines and examine five plots at a time. Five is considered the optimum number because four out of five stocked plots coincides with 80% stocking. After the first five plots have been examined, drop the first plot in the line and add one plot on the end (running average of five plots). Continue progressing to the end of the line until the last five plots have been checked.
   b. A section of five plots is called stocked if four of the plots are stocked. All stocked plots are considered regardless of conifer or deciduous status. A section of five plots is called un-stocked if it contains zero to three stocked plots. If there are fewer than five plots in a line, all plots must be stocked in order to call the whole line stocked. If there are more than five plots in a line, the beginning of the first un-stocked five-plot section and the end of the last un-stocked five-plot section should be marked to select the un-stocked portion of a line (see Appendix 5 for an example).

   After each line is checked and marked, the marked areas should be joined to show the boundaries of the suspected un-stocked areas. The same procedure is to be repeated by running the five-plot, moving average perpendicular to the first direction. An area shown to be NSR in both directions shall be considered the NSR area.

2. Identifying stocked areas within a generally un-stocked opening:
   The procedure is the same as for identifying un-stocked areas in a stocked opening, except a five plot section is considered stocked only when all the plots are stocked. This means 100% stocking. The procedure described above should not be used to delineate SR/NSR patches that are smaller than 4 ha, and there should be a minimum of 10 plots in the sub-unit. This restriction is necessary because if the number of plots is very small, there is a high probability that the area will be classed incorrectly.

3. Procedure for Wet, Low Density Standard:
   The stocking requirement for Wet, Low Density Standard surveys is 50% rather than 80% on establishment and performance surveys. The procedure is the same as above, except that instead of a five plot running average, a four-plot average is used. A section of four plots is called stocked if two or more of the plots are stocked.

Some logical adjustments may be made around the border of the NSR area. When the above procedure has been completed, calculate the area of each NSR patch to determine if any of these are greater than 4 ha. Un-stocked portions of generally stocked openings greater than 4.0 ha will require reforestation treatment and must be shown on the final map that is submitted to Alberta.

Un-stocked areas between 2.0 and 4.0 ha in size are to be mapped in a manner acceptable to Alberta. Areas under LOC are exempt from this procedure.

The area of a NSR patch is to be entered in the "Survey Results" line on the Regeneration Survey Information Sheet.

6.1.2 Roads and Landings Exceeding 5% of Opening Area

Compacted areas resulting from roads and landings often regenerate poorly. These areas are to be mapped during the regeneration survey when the area exceeds 5% of the total opening area, in a manner acceptable to the Alberta. While there may be no direct effect on the stocking status of the opening when the area exceeds 5%, the opening is to be included in a population of openings to be analyzed at the time of the next timber supply analysis to ensure that the effect of roads and landings is addressed. Areas under LOC are exempted because they are withdrawn from the opening area.

The area covered by roads and landings is to be entered in the "Survey Results" line on the Regeneration Survey Information Sheet. Include also the figure for the percentage of the total area of the opening that is in roads and landings. To do this, take the area estimated for roads and landings, divide that figure by the total "corrected" area (area of opening after survey completed) for the opening, and multiply by 100.

6.2 Calculating the Opening Stocking Percent and Opening Status

6.2.1 Opening Stocking Percent

Once any additional plots have been entered (Section 5.4.3), and the individual plot status has been recorded on the tally sheets, the opening stocking can be calculated using the Regeneration Survey Summary Sheet on the back of the Map Sheet. The procedure for calculating the opening stocking percent is the same as outlined in Section 5.4.2.

The final opening stocking percent is to be entered in the "Survey Results" area on the Regeneration Survey Information Sheet.

6.2.2 Opening Status

There are four requirements for achieving a Satisfactorily Restocked (SR) status (Establishment) or a Free-to-Grow status (Performance) for an opening:

- The opening stocking percent must be 80% or more, unless the opening is a Wet, Low Density standard opening where the minimum is 50%, and
- The minimum stocking percentages for deciduous and coniferous must be met, and
- The minimum average density and minimum average deciduous crop tree height must be met (for D standard)
- The opening has no contiguous non-stocked areas exceeding 4.0 ha as determined by methods provided in Section 6.1.1.

Using the appropriate section in the manual, determine whether the opening is Conditionally Restocked (**CSR**), Satisfactorily Restocked (**SR**), or Not Satisfactorily Restocked (**NSR**).

The final opening status is to be entered in the "Survey Results" area on the Regeneration Survey Information Sheet.

7.0 Survey Submission

Under the authority of Section 141.2 of the Timber Management Regulation, Alberta requires that in order for a regeneration survey submission to be acceptable to the Minister, the submission shall adhere to the conditions described in this section.

7.1 RFP Validation

All entities responsible for submitting the regeneration surveys to Alberta shall complete and sign the Regeneration Survey Submission Cover Page (Appendix 6). The Regeneration Survey Submission Cover Page must be validated by a registered forestry professional (RFP) *except* where the entity responsible for submitting the survey(s) harvests less than 30,000m^3 annually. Submissions from FRIAA shall be validated by a RFP. Persons submitting survey(s) from entities exempted from validation, and who are not a RFP, are still required to complete and sign the Regeneration Survey Submission Cover Page.

It is the responsibility of the person signing the Regeneration Survey Submission Cover Page, whether a RFP or not, to ensure that the submission:

1. Adheres to all components of the required Quality Assessment/Quality Control program (section 7.2), **and**
2. Includes survey(s) conducted according to the methods detailed in this Manual or, according to an alternative method as approved by Alberta, **and**
3. Complies with the requirements for submission timing and format (section 7.3).

7.2 Quality Assessment and Quality Control

As of May 01, 2008, a *documented* quality assessment and quality control (QA/QC) program must be implemented by each entity responsible for submitting regeneration surveys to Alberta.

All QA/QC programs must address the following components:

1. **Training**: All persons involved with regeneration surveys must be trained to enable them to accurately carry out the necessary tasks, including data gathering (field surveys) and compilation of results. QA/QC programs will:
    a. Identify necessary surveyor competencies.
    b. Identify training requirements for acquiring/maintaining competencies through:
        i. Initial classroom and/or field training,
        ii. Number of surveys each surveyor must conduct annually, and
        iii. Periodic training updates (i.e. for changes to survey methods or standards).
    c. Identify specific outcomes/remedial actions where surveys are found to have been carried out by personnel lacking necessary training/competencies.

    Evidence of successful completion of necessary training for all persons involved with regeneration surveys must be maintained and made available to Alberta upon request.

2. **Field quality assessments ("field" checks)**: QA/QC programs will:
    a. Employ field-level quality assessments which:
        i. Utilize sampling intensities and methods that account for variability in surveyors, survey method and strata, and,
        ii. Publish clear accuracy/completeness standards for survey layout and data collection.
    b. Identify specific outcomes/remedial actions where inaccurate methods and/or data are found.

    Documentation of all field quality assessment findings and associated outcomes will be maintained and made available to Alberta upon request.

3. **Data quality assessments ("paper" checks)**: QA/QC programs will:
    a. Employ submission-level data quality assessments which:
        i. Utilize sampling intensities and methods that evaluate accuracy and integrity of survey submissions, ensuring a reasonable opportunity to identify and resolve issues prior to submission to Alberta.
        ii. Publish clear accuracy/completeness standards for all survey "paperwork", including survey card information, plot data, mapping and compilation of results.
    b. Identify specific outcomes/remedial actions for errors/issues affecting the accuracy or integrity of submissions.

    Documentation of all data quality assessment findings and associated outcomes will be maintained and made available to Alberta upon request.

7.3 Submission Timing and Format

Regeneration surveys must be submitted to Alberta on or before **April 30th** of the timber year in which they are due, as described in the Timber Management Regulation (sections 141.6, 141.7 and 141.8).

Submissions may be either paper or electronic, but either method must be accompanied by a completed and signed Regeneration Survey Submission Cover Page. The Regeneration Survey Submission Cover Page (bearing the required signature) may be submitted digitally, but must be in a proprietary file format (for example, Adobe Acrobat ".pdf") for digital signature protection.

7.3.1 Paper submission to Alberta

An acceptable submission for each opening surveyed to the standard of this Manual shall contain all of the following:

1. Tally cards (section 5.3) and final map (section 6.1). These should be contained in one package.

2. Stocking percentages, opening status and other survey results and data as shown on the Regeneration Survey Information Sheet and on the final Map Sheet (compilation, section 6.2).
3. Accompanying Regeneration Survey Submission Cover Page.

OR

An acceptable submission for each opening surveyed to an approved alternative survey methodology shall contain all of the following:

1. Survey results and data as per the approved survey methodology and reporting requirements.
2. Accompanying Regeneration Survey Submission Cover Page.

7.3.2 Electronic Data Submission

An acceptable electronic submission for each opening in the Regeneration Survey is as described in the ARIS Industry Operations Manual available through Alberta plus accompanying Regeneration Survey Submission Cover Page or as otherwise approved by Alberta.

7.4 Survey Monitoring by Alberta

7.4.1 Monitoring Methods

Alberta deems regeneration survey data of critical importance to assessing the status of the regenerating forest. Consequently, Alberta will undertake monitoring of regeneration survey data quality and accuracy. Monitoring shall consist of the following:

- "Active" survey monitoring shall be instituted as of May 2008 via "program checks" to ensure that QA/QC programs (as set out in section 7.2) are being followed as documented.
- Post-submission monitoring of regeneration surveys annually will include assessing submission results for consistency:
    - With the ARIS record,
    - With approved regeneration survey protocols, and
    - Of all derived variables via independent compilation of original field (tally) data.
- Post-submission accuracy assessments shall be made through completion of independent field regeneration surveys on a sub-set of openings for each timber year.

7.4.2 Outcomes of Monitoring

Where survey submissions are found to be of unacceptable quality, Alberta may take any of the following actions:

- Reject surveys based on errors in data gathering, compilation and/or reporting;
- Require rejected surveys to be redone;
- Prohibit rejected surveys from inclusion in strata balancing submissions; and/or,
- Register a complaint with the respective RFP's College.

Alberta may also require that a QA/QC program be reviewed where consistent errors have been noted during monitoring, or where "program checks" have revealed that a QA/QC program is not being followed.

Appendices

Please note: Appendix 6, Species Identification, listing common Alberta trees species and their characteristics is under a separate cover and is not included in this document.

Appendix 1 – Glossary

Alberta	The Department of Sustainable Resource Development, or as amended from time to time, with the responsibility for the delivery of the Forest Act and applicable regulations and policies.
Advance Growth:	A tree that was established in advance of harvest and which meets all the standards for acceptability.
Arithmetic mean:	The average obtained by dividing the sum of the items by the number of individual items.
Buffer:	An area of forest or vegetative cover that is left in a natural state on the landscape usually to provide protection for some natural feature or serve as a wildlife corridor.
Competitor:	A broadleaved tree or woody shrub that exceeds the limits for height relative to the height of a conifer tree and is growing within a specified distance of a potential coniferous crop tree.
Coniferous:	Needle-leafed trees, which produce cones (includes larch spp.)
Control line:	A line established at 400 m intervals for control of plot location. The control line runs across the long axis of the opening and is marked at points where survey lines cross it.
Coppice:	A natural vegetative regeneration process where saplings regenerate from a stump or root. Multiple healthy stems may be observed coming from a single stump/root.
Crop tree:	A crop tree is the tallest seedling/tree on the plot that has achieved the minimum height requirements as defined in the standards for the type of survey and the tree species.
Cylinder:	The volume of space described by a 1.78m radius arc, centred on a crop conifer tree, extending the height of the crop conifer.
Deciduous:	Broadleaved tree species that lose their leaves in the fall.
Demerit:	Demerits are deductions given as a result of errors committed when performing a regeneration survey and are determined by the check survey. More than four (4) demerit marks will normally constitute grounds for failure of the survey.
Density:	The number of trees on the plot, by species, greater than or equal to 30 cm in height. The density for survey purposes is usually expressed as trees per plot. The average density for each species is the sum of the trees recorded on every plot, divided by the total number of plots.

DFMP:	Detailed Forest Management Plan – A long-term plan prepared by the timber operator to outline higher-level management objectives, sustainability and timber productions assumptions of a Forest Management Area.
Disposition:	The legal document that provides the timber rights to harvest the timber to the disposition holder.
Forest Area:	A geographic administrative unit within a Region Forest Area of Alberta.
Drainage class:	Actual water content in excess of field moisture capacity, and the extent during which such excess water is present in the plant rooting zone. Seven classes are recognized, ranging from very rapidly to very poorly drained.
Establishment:	The Establishment survey is the first survey required after harvesting. The survey must be carried out in a specified time relative to when harvest is complete.
Field number:	The number assigned to an opening and which normally appears on the AOP map of harvest plan map.
FMA:	Forest Management Agreement
FMU:	Forest Management Unit
Free-to-Grow:	A crop tree that has achieved the minimum height requirements and has up to the allowable limit of competitor trees and shrubs with the FTG cylinder as defined in the standards for the type of survey and the tree species.
Growing Season	The period between June 20th and August 1st in any one calendar year. Where treatments occur prior to June 20th and surveys are conducted after August 1st (in the same calendar year), one growing season is determined to have elapsed (despite both activities occurring in the same calendar year).
Horizontal projection:	A flat view of the ground that is corrected for the additional and area created by topographic features.
Hybrid:	The offspring of two plants of different varieties. They are the result of tree improvement programs to improve the growth or other characteristics of the native varieties.
Landing:	An area or number of areas, found on an opening where harvested logs are temporarily stored until they can be hauled. Landings are usually associated with opening logging roads and may experience different regeneration results due to possible impact to the soil from operations.
Leader:	The top growth on a seedling that results from the current or past year's growth.

Natural Subregion:	A geographic area, containing sites with similar characteristics, and defined by plant species composition and abundance of reference ecosites.
NSR:	Not Satisfactorily Restocked – The state resulting from failing to attain the conditions described in the Regeneration Survey Manual for the type of survey, species, height, etc. The term may refer to an individual plot, a portion of an opening, or an entire opening.
Opening:	The unit for reforestation management. A cutblock is an area or unit of planned or actual timber harvest. More than one opening may exist within a cutblock at the time of AOP approval. Openings are created at the time of entry into ARIS by May 15th of the year of cut for the cutblock.
Opening number:	A unique number assigned to an opening based on the legal location of the centre of the harvest area (stand opening).
Overlapping plot:	A plot that contains both a coniferous crop tree and a deciduous crop tree.
Performance:	The second survey required of regenerating openings designed to ensure established trees are performing to specified standards and are likely to develop into stands that will meet management objectives. The survey must be carried out in a specified time relative to when harvest is complete.
Provisionally FTG plot	Contains a conifer crop tree that meets the minimum performance indicator requirements for its species group and that also has up to the allowable level of competitors within the FTG cylinder
Riparian area:	A terrestrial area where the vegetation and microclimate are highly influenced by perennial and/or intermittent water associated high water tables and soils that exhibit some wetness characteristics.
Root collar:	The base of a seedling where the root ends and the stem begins. Sometimes characterized by a node.
Sample plot:	A regeneration survey sample plot is 1/1000 ha or 10m^2 in size, circular in shape. It has a radius of 1.78m.
SR:	Satisfactorily Restocked – A state resulting from meeting or exceeding the conditions described in the Regeneration Survey Manual for the type of survey, species, height, etc. The term may refer to an individual plot, a portion of an opening, or an entire opening.
Stocking %:	The sum of all the satisfactorily restocked plots on the opening, divided by the total number of valid plots, multiplied by 100 to express term as a percent.

Strata Standard:	A combination of minimum conditions an opening must meet to be placed in one of the four recognized strata (C, CD, DC, or D).
Survey line:	Survey lines run perpendicular to the control lines, parallel with each other and at a calculated spacing. Plots are located along the survey line.
Timber Year:	The period of time between May 01 and April 30 of the following calendar year
Tree height:	The height of a seedling or sapling as measured from the base of the tree at the ground level, to the uppermost point of the living tissue.
Valid Plot:	A plot within the Regeneration Survey that is established via a field grid and is assessed for its attributes in order to establish it's stocking condition and the density of trees on it. A "Deleted Plot" is not a Valid Plot.

Appendix 2 – Statistical Accuracy Standards

The systematic survey method has been designed to satisfy the statistical accuracy standards outlined below. The error levels are inherent in the survey design and do not include error on the part of the surveyor. Accuracy will be further reduced if human error, either by omission or commission, is introduced into the sampling.

The sampling error for an individual opening can be calculated using the formula:

$$E = +/- 200 \sqrt{\frac{p \times q}{n}}$$

Where : E = Sampling error in percent
p = proportion of stocked plots expressed as a decimal, e.g., 70% = 0.70
q = 1-p; proportion of plots unstocked as a decimal, e.g., 1.00- 0.70 = 0.30
n = number of plots established

The following table presents the statistical accuracy agreed to for Alberta Regeneration Surveys:

OPENING SIZE (ha)	STATISTICAL ACCURACY
0 – 0.9	Variable
2 – 4	Within ± 12.5% with 95% confidence
4 +	Within ± 10.0% with 95% confidence when stocking is 80% or greater

Appendix 3 – Number of Sample Plots Required

The total number of plots required to sample any given area can be calculated using the formula:

$$n = 4 \sqrt{\frac{p \times q}{E^2}}$$

Where : n = number of sample plots to be established
p = proportion of plots stocked expressed as a decimal
q = 1 - p; proportion of plots unstocked expressed as a decimal
E = maximum allowable sampling error, which must not exceed:
± 10.0% for Openings larger than 4.0 ha
± 12.5% for Openings 2.0 to 4.0 ha where the stocking result indicated by the survey is 80% or more

The values of p and q are not known for the area prior to survey, so an assumed stocking value of 80% is to be used.

OPENING SIZE:	SAMPLE PLOTS:
0.1 – 1.9 ha	Min. 12.4 plots/ha
2.0 – 4.0 ha	Initially 41 plots/opening 41 plots: If stocking 0 - 72% or 80 - 100% 54 plots: If stocking 73 - 79%
4.1 – 24.0 ha	Initially 64 plots/opening 64 plots: If stocking 0 - 72% or 80 - 100% 84 plots: If stocking 73 - 79%
24.0+ ha	Minimum 2.77 plots/ha

Appendix 4 – Line and Plot Spacing

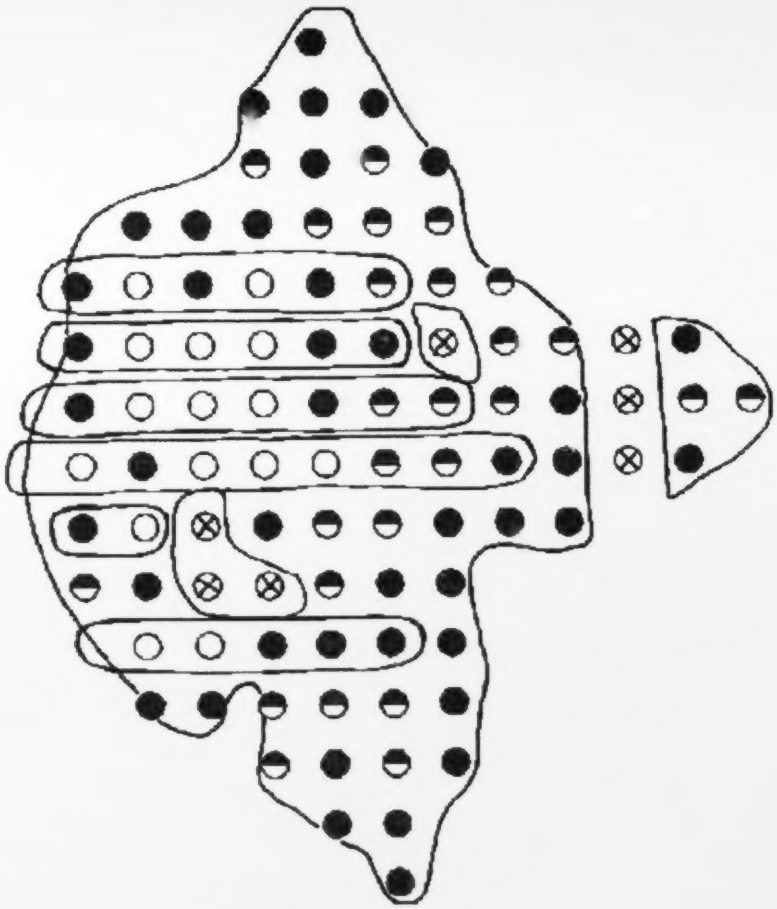
Survey Line and Sample Plot Spacing

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/ha	Allowable Error	Number of Plots
0.5	806.45	28.40	12.40	32.66	6
1.0	806.45	28.40	12.40	22.19	12
1.5	806.45	28.40	12.40	18.35	19
2.0	487.80	22.09	20.50	12.50	41
2.5	609.76	24.69	16.40	12.50	41
3.0	731.71	27.05	13.67	12.50	41
3.5	853.66	29.22	11.71	12.50	41
4.0	975.61	31.23	10.25	12.50	41
4.5	703.13	26.52	14.22	10.00	64
5.0	781.25	27.95	12.80	10.00	64
5.5	859.38	29.32	11.64	10.00	64
6.0	937.50	30.62	10.67	10.00	64
6.5	1015.63	31.87	9.85	10.00	64
7.0	1093.75	33.07	9.14	10.00	64
7.5	1171.88	34.23	8.53	10.00	64
8.0	1250.00	35.36	8.00	10.00	64
8.5	1328.13	36.44	7.53	10.00	64
9.0	1406.25	37.50	7.11	10.00	64
9.5	1484.38	38.53	6.74	10.00	64
10.0	1562.50	39.53	6.40	10.00	64
10.5	1640.63	40.50	6.10	10.00	64
11.0	1718.75	41.46	5.82	10.00	64
11.5	1796.88	42.39	5.57	10.00	64
12.0	1875.00	43.30	5.33	10.00	64
12.5	1953.15	44.19	5.12	10.00	64
13.0	2031.25	45.07	4.92	10.00	64
13.5	2109.38	45.93	4.74	10.00	64
14.0	2187.50	46.77	4.57	10.00	64
14.5	2265.63	47.60	4.41	10.00	64
15.0	2343.75	48.41	4.27	10.00	64
15.5	2421.88	49.21	4.13	10.00	64
16.0	2500.00	50.00	4.00	10.00	64
16.5	2578.13	50.78	3.88	10.00	64
17.0	2656.25	51.54	3.76	10.00	64
17.5	2734.38	52.29	3.66	10.00	64
18.0	2812.50	53.03	3.56	10.00	64
18.5	2890.63	53.76	3.46	10.00	64
19.0	2968.75	54.49	3.37	10.00	64
19.5	3046.88	55.20	3.28	10.00	64
20.0	3125.00	55.90	3.20	10.00	64
20.5	3203.13	56.60	3.12	10.00	64
21.0	3281.25	57.28	3.05	10.00	64

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/ha	Allowable Error	Number of Plots
21.5	3359.38	57.96	2.98	10.00	64
22.0	3437.50	58.63	2.91	10.00	64
22.5	3515.63	59.29	2.84	10.00	64
23.0	3593.75	59.95	2.78	10.00	64
23.5	3671.88	60.60	2.72	10.00	64
24.0	3750.00	61.24	2.67	10.00	64
24.5	3610.11	60.08	2.77	9.71	68
25.0	3610.11	60.08	2.77	9.61	69
25.5	3610.11	60.08	2.77	9.52	71
26.0	3610.11	60.08	2.77	9.43	72
26.5	3610.11	60.08	2.77	9.34	73
27.0	3610.11	60.08	2.77	9.25	75
27.5	3610.11	60.08	2.77	9.17	76
28.0	3610.11	60.08	2.77	9.08	78
28.5	3610.11	60.08	2.77	9.00	79
29.0	3610.11	60.08	2.77	8.93	80
29.5	3610.11	60.08	2.77	8.85	82
30.0	3610.11	60.08	2.77	8.78	83
30.5	3610.11	60.08	2.77	8.70	84
31.0	3610.11	60.08	2.77	8.63	86
31.5	3610.11	60.08	2.77	8.56	87
32.0	3610.11	60.08	2.77	8.50	89
32.5	3610.11	60.08	2.77	8.43	90
33.0	3610.11	60.08	2.77	8.37	91
33.5	3610.11	60.08	2.77	8.30	93
34.0	3610.11	60.08	2.77	8.24	94
34.5	3610.11	60.08	2.77	8.18	96
35.0	3610.11	60.08	2.77	8.12	97
35.5	3610.11	60.08	2.77	8.07	98
36.0	3610.11	60.08	2.77	8.01	100
36.5	3610.11	60.08	2.77	7.96	101
37.0	3610.11	60.08	2.77	7.90	102
37.5	3610.11	60.08	2.77	7.85	104
38.0	3610.11	60.08	2.77	7.80	105
38.5	3610.11	60.08	2.77	7.75	107
39.0	3610.11	60.08	2.77	7.70	108
39.5	3610.11	60.08	2.77	7.65	109
40.0	3610.11	60.08	2.77	7.60	111
40.5	3610.11	60.08	2.77	7.55	112
41.0	3610.11	60.08	2.77	7.51	114
41.5	3610.11	60.08	2.77	7.46	115
42.0	3610.11	60.08	2.77	7.42	116

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/ha	Allowable Error	Number of Plots
42.5	3610.11	60.08	2.77	7.37	118
43.0	3610.11	60.08	2.77	7.33	119
43.5	3610.11	60.08	2.77	7.29	120
44.0	3610.11	60.08	2.77	7.25	122
44.5	3610.11	60.08	2.77	7.21	123
45.0	3610.11	60.08	2.77	7.17	125
45.5	3610.11	60.08	2.77	7.13	126
46.0	3610.11	60.08	2.77	7.09	127
46.5	3610.11	60.08	2.77	7.05	129
47.0	3610.11	60.08	2.77	7.01	130
47.5	3610.11	60.08	2.77	6.97	132
48.0	3610.11	60.08	2.77	6.94	133
48.5	3610.11	60.08	2.77	6.90	134
49.0	3610.11	60.08	2.77	6.87	136
49.5	3610.11	60.08	2.77	6.83	137
50.0	3610.11	60.08	2.77	6.80	138

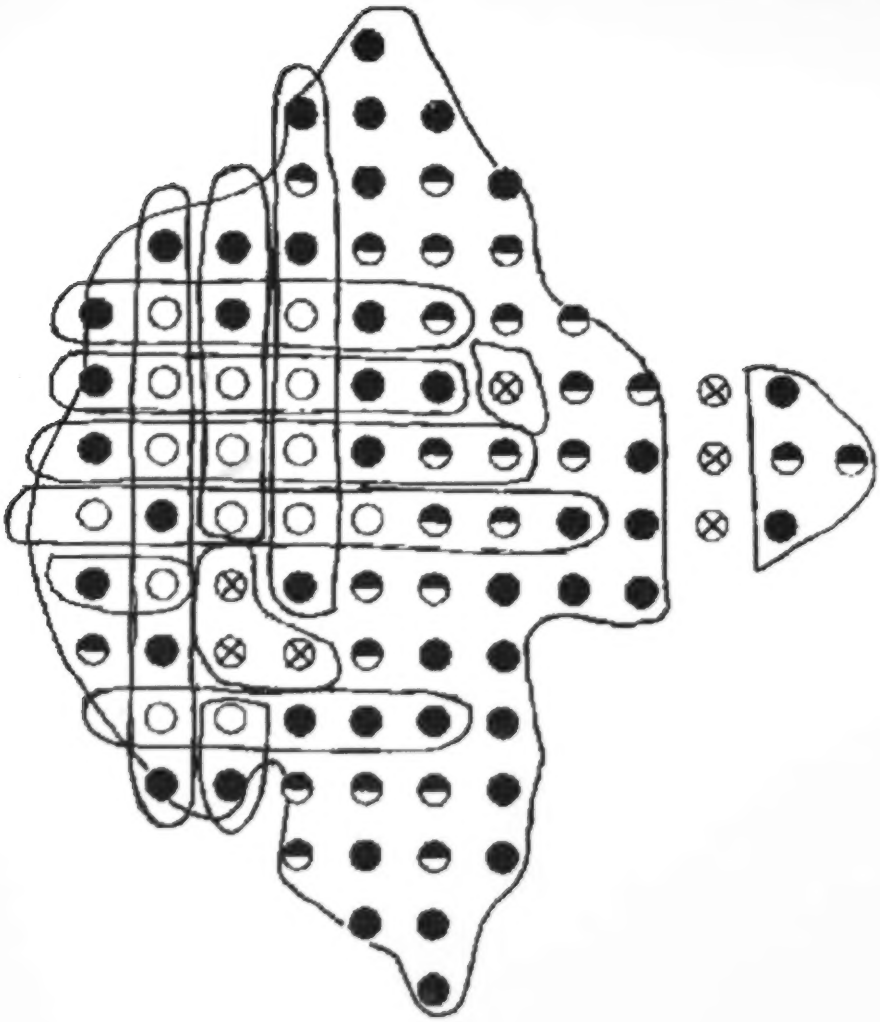
Appendix 5 – Delineating NSR areas larger than 2.0 ha (examples)



Step 1: Example of west to east delineation of suspected NSR area

CD – ESTABLISHMENT SURVEY

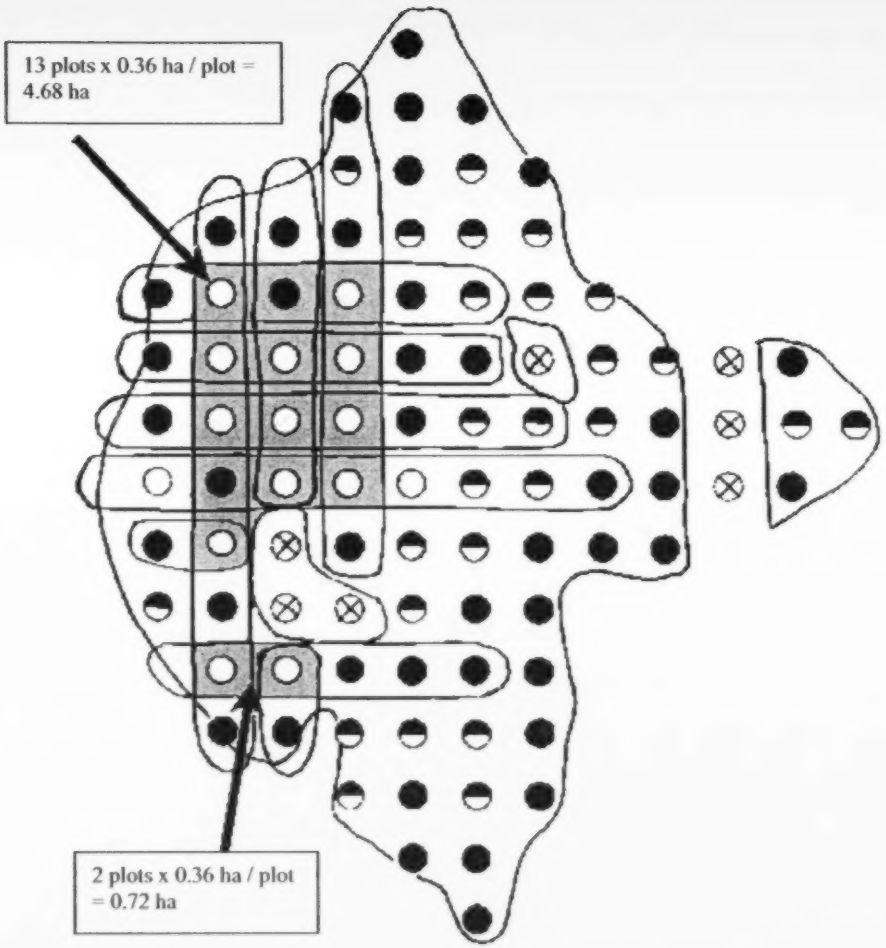
Opening Area	- 30.5 ha	
Valid Plots	- 84 plots	
Grid 60 x 60m	- 0.36ha/plot	
NSR	- 15 plots	
SR- Coniferous	- 43 plots/ 84	= 51.19%
SR- Deciduous	- 26 plots/ 84	= 30.95%
Stocking Percent		= 82.14%



Step 2: North to south delineation of suspected NSR area

CD – ESTABLISHMENT SURVEY

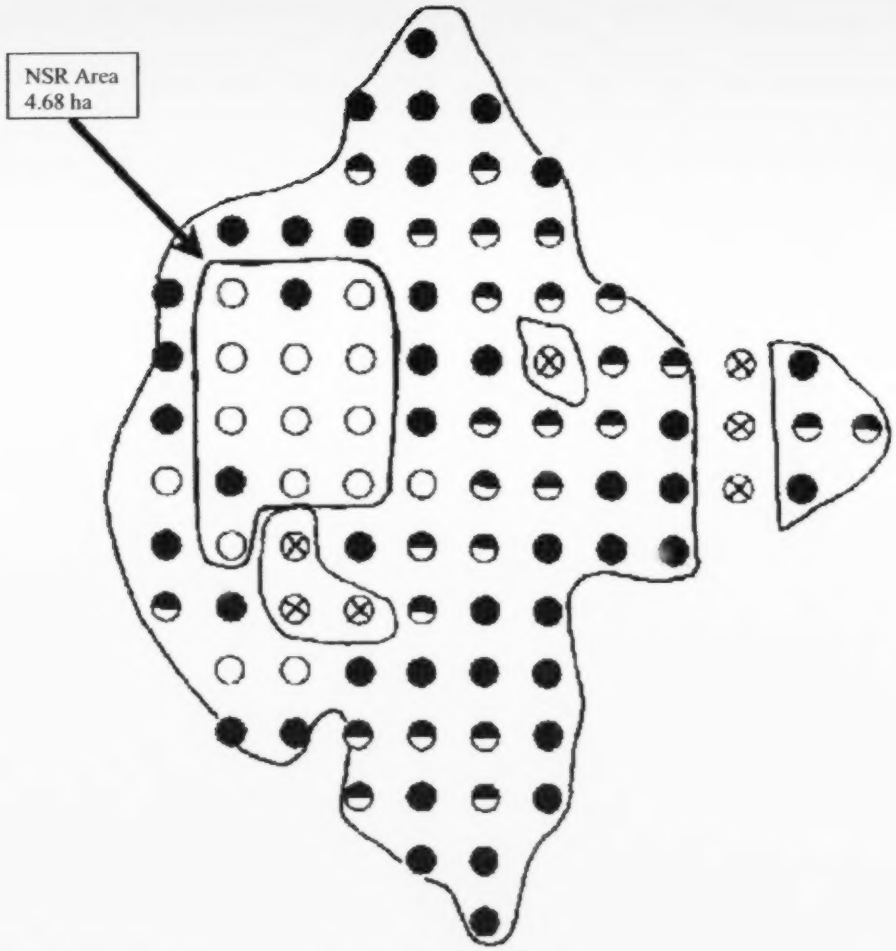
Opening Area	- 30.5 ha	
Valid Plots	- 84 plots	
Grid 60 x 60m	- 0.36ha/plot	
NSR	- 15 plots	
SR- Coniferous	- 43 plots/ 84	= 51.19%
SR- Deciduous	- 26 plots/ 84	= 30.95%
Stocking Percent		= 82.14%



Step 3: Overlapping area following east-west and north-south delineation of suspected NSR area.

CD – ESTABLISHMENT SURVEY

Opening Area	- 30.5 ha	
Valid Plots	- 84 plots	
Grid 60 x 60m	- 0.36ha/plot	
NSR	- 15 plots	
SR- Coniferous	- 43 plots/ 84	= 51.19%
SR- Deciduous	- 26 plots/ 84	= 30.95%
	Stocking Percent	= 82.14%



Step 4: NSR area greater than 4.0 ha identified on the opening map.

CD – ESTABLISHMENT SURVEY

Opening Area	- 30.5 ha	
Valid Plots	- 84 plots	
Grid 60 x 60m	- 0.36ha/plot	
NSR	- 15 plots	
SR- Coniferous	- 43 plots/ 84	= 51.19%
SR- Deciduous	- 26 plots/ 84	= 30.95%
	Stocking Percent	= 82.14%

This opening is NSR by virtue of the > 4 ha contiguous NSR area.

Appendix 6 Species Identification

This appendix is under a separate cover available at:

http://www.srd.alberta.ca/forests/pdf/Regen_App_6.pdf

Appendix 7 – Regeneration Survey Submission Cover Page

Regeneration Survey Submission Cover Page

Company Name/Address

_____
_____
_____
_____
_____

Timber Year: May 1, 20___ to Apr.30, 20___

List of ARIS Opening Numbers for which regeneration survey data is being submitted:
A. Establishment Surveys:
(or as attached)

B. Performance Surveys:
(or as attached)

Summary of Preventive and Correction Actions - from Quality Assurance/Quality Control Program for openings included in this submission (if none please indicate)

Declaration:
I do hereby declare that this submission:

- Adheres to all components of the required Quality Assessment/Quality Control program, **and**
- Includes only survey(s) that have been conducted according to the methods detailed in the Regeneration Survey Manual or, according to an alternative method as approved by Alberta, **and**
- Complies with the requirements for submission timing and format.

Validated/Signed by: Registration # (as applicable) Dated: